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Office of the Assistant Secretary for Policy Development and Research

Final Rehabilitation Guidelines

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Office of the Assistant Secretary for Policy Development and Research

[Docket No N-80-1003]

Final Rehabilitation Guidelines

AGENCY: Department of Housing and Urban Development.

ACTION: Notice of final rehabilitation guidelines.

SUMMARY: HUD is hereby promulgating the final Rehabilitation Guidelines developed in accordance with Section 903 of Pub. L. 95-557, "Housing and Community Development Amendments of 1978." These Guidelines are intended for the voluntary adoption by States and communities to be used in conjunction with existing building codes by State and local officials in the inspection and approval of rehabilitated properties.

FOR FURTHER INFORMATION CONTACT: Robert J. Kapsch, Program Manager, Division of Energy, Building Technology and Standards, Room 8164, Department of Housing and Urban Development, 451 Seventh Street, SW., Washington, D.C. 20410. Telephone (202) 755-8154. This is not a toll free number.

SUPPLEMENTARY INFORMATION: HUD published the draft Rehabilitation Guidelines in the **Federal Register** for public comment on November 5, 1979 (44 FR 63760). Thirty four communications, containing 188 comments, were received. After careful consideration of the comments received, the draft Rehabilitation Guidelines were revised, in part. A summary of the major changes made to the Guidelines is published herein.

The draft Rehabilitation Guidelines published in the **Federal Register** on November 5, 1979 contained eight specific guidelines:

- Guideline for Setting and Adopting Standards for Building Rehabilitation
- Guideline for Municipal Approval of Building Rehabilitation
- Statutory Guideline for Building Rehabilitation
- Guideline for Managing Official Liability Associated With Building Rehabilitation
- Egress Guideline for Residential Rehabilitation
- Electrical Guideline for Residential Rehabilitation
- Plumbing Drain-Waste-Vent Guideline for Residential Rehabilitation
- Guideline for Fire Ratings of Archaic Materials and Assemblies
- Public comment was both general and specific in nature.

1. General Comments

Two comments were received that the guidelines were difficult to read and one comment was received that indicated that the guidelines would be difficult to use in the field. The format of the final guidelines has been reorganized to make the guidelines less complex and to improve their overall readability. As published, the guidelines will be in a format suitable for field use.

A number of commenters cited the need for supplemental information about issues not directly addressed in the guidelines. These included the following code-related rehabilitation problems: training of inspectors; structural and seismic safety; the need for more specific code equivalencies; accessibility for the handicapped; the liability of design professionals; energy conservation; state preemption of local codes; inclusion of additional technical and regulatory detail; and building department budgets. Most of these issues were previously considered by HUD for inclusion in the guidelines, but were not addressed either due to time and monetary constraints, or for state-of-the-art limitations or for other practical reasons. All of the issues mentioned will be considered by HUD for development as future guidelines.

Several comments were addressed to issues not related to the rehabilitation guidelines, such as the need for housing for the elderly, mobile home research, problems of lead based paint standards, and the general need for building codes and standards. Where possible, these comments were referred to those offices in HUD active in these areas.

Two commenters requested that the guidelines be tabled or delayed, citing the twelve month limitation imposed by Congress for the development of the guidelines as inadequate. Since the time schedule for promulgating these guidelines have been legislatively determined, HUD did not delay or table the promulgation of the final Rehabilitation Guidelines.

Two comments were received indicating the belief that the guidelines were a building code. Five other comments expressed concern that the guidelines either might be interpreted as a code or, at some time in the future, might be imposed as a code. Although the guidelines were clearly identified as such and were not published in code language, emphasis has been added to the final guidelines clarifying their function under Section 903 of the Act.

Two comments were received indicating that the guidelines did not contain a statement that their purpose was to promote rehabilitation. The final guidelines remedy this.

Two comments were received regarding recommended actions to be taken by HUD following the promulgation of the final guidelines. These included a recommendation to provide assistance in their use and to institute a mechanism to expand, revise and update the contents of the guidelines. Both comments will be considered by HUD in the development of future activities associated with these guidelines.

2. Specific Comments

Because of the technical nature of many of the comments received, HUD used the services of the National Institute of Building Sciences and selected nationally recognized experts to aid in evaluating each of the technical comments received and to provide their recommendations to HUD. The following is a description of the substantive modifications or revisions made to each of the eight individual guidelines.

a. Guideline for Setting and Adopting Standards for Building Rehabilitation: Fourteen commenters provided numerous comments directed at this guideline. In response to these comments, the following changes were made:

- The narrative on historic preservation was clarified in Part II, and a recommendation added in Part III dealing with the inclusion of historic preservation waiver clauses.
- A discussion of the approach to residential rehabilitation taken by the State of California was added to both the guideline and as Appendix 6;
- The description of San Francisco's approach to rehabilitation was amended in both the guideline and in Appendix 3.
- The description of Denver's approach to rehabilitation was amplified according to additional information received;
- A caveat to localities governed by statewide mandatory codes was added to the guideline;
- The discussion and diagrams related to the varying levels of performance discussed in Part I were clarified;
- A discussion of the scope of rehabilitation covered was added;
- Three of the four examples of retroactive provisions were deleted from the appendix as one example was considered sufficient;
- A modification was made to Appendix 10 adding a discussion on the use of live load placards;
- An additional appendix was added citing an article from the Southern

Building Magazine, February/March 1980, entitled, "Rehabilitation of Existing Building: An Achievable Goal"

Three comments were received to delete or limit the discussion of the 25/50 percent rule because of the deficiencies of this rule. HUD did not delete or limit the discussion of this rule as it is a major factor in most code jurisdictions and is being used to encourage rehabilitation in many of those jurisdictions.

Several comments were made criticizing the guideline's discussion of the changing levels of safety within and among building, housing, maintenance and hazard abatement codes; however, this discussion was considered essential to the guidelines and has been retained in essence.

The revised guideline together with Appendix 3, and the new Appendices 6 and 11 together with a bibliography are being reproduced in this notice.

b. Guideline for Approval of Building Rehabilitation: Two comments were received. The first brought Seattle's rehabilitation program to HUD's attention and the second stated that many building departments already follow these or similar procedures suggested in the guideline. Although there is no doubt that many building departments follow these or similar procedures, it is also known that many do not. HUD therefore is promulgating this guideline. However, for purposes of clarification, the guideline's format was reorganized to stress parallels between submittal, review and approval procedures for rehabilitation and those required for new construction. References were added to the guideline regarding Seattle's rehabilitation program and its field inspection procedure, and to Portland's Outreach program. The term "Municipal" was deleted from the title of the final guideline.

The full revised guideline is being reproduced in this notice.

c. Statutory Guideline for Building Rehabilitation: Two comments were received directed at this guideline. The first recommended that a definition of rehabilitation be added to the guideline. Although it is difficult to define rehabilitation, because many communities use the term in many different ways, a discussion of the scope of rehabilitation has been added to the *Guideline for Setting and Adopting Standards for Building Rehabilitation.* The second comment suggested an improved appeals procedure. A review of the subject indicated that there was little substantive difference between the suggested procedure and that described in the guideline. This guideline, therefore, has not been modified and will be adopted as published in the draft.

d. Guideline for Managing Official Liability Associated With Building Rehabilitation: Two comments were received. The first suggested that liability may not be a significant issue in building rehabilitation. The problem identification study undertaken as a part of the guidelines preparation indicated that official liability was viewed as a serious concern in rehabilitation projects by building officials throughout the country. No change, therefore, was made. The second suggested that the liability of designers of rehabilitation projects also be covered. HUD is reviewing this suggestion as part of its efforts in developing future guidelines. This guideline therefore has not been modified and is being adopted as published in draft.

e. Egress Guideline for Residential Rehabilitation. Eight commentors provided a number of comments directed toward this guideline. Based on the comments received and a thorough technical review resulting from these comments, the following changes were made:

- The assumptions upon which the guideline is based were restated and clarified, including:
  - the guideline is intended for use only by persons knowledgeable in fire protection and the principals of building construction;
  - the guideline stresses the retention of as many of the existing components of the egress system as possible, provided that they assure approximately equivalent levels of fire safety performance to that intended by existing codes;
  - the guideline is meant to apply whenever current code requirements are triggered;
  - the problem/solution statements shown in the guideline are meant to be representative and not exhaustive.
- A number of revisions were made to the text of each egress category, including:
  - a number of code intent statements were modified;
  - one problem/solution statement was eliminated since it was largely redundant;
  - one problem/solution statement was added, dealing with the adequacy of horizontal exits;
  - wherever the guideline recommends deviating from existing code requirements, the installation of single station smoke detectors has been made a part of the solution statement;
  - a number of references to the Uniform Building Code and its Appendix Chapter 12 were revised and corrected;
  - The guideline's format was substantially reorganized to accommodate the above revisions.

A recommendation to delete the problem/solution statement that conditionally allows the use of a single exit in a three story building was not adopted since an approximately equivalent level of fire safety to that required by existing codes was provided by the solution stated. A comment criticizing the guideline on reliance on automatic fire suppression systems and the use of domestic water supplies for sprinkler systems was considered, but the emphasis on these solutions was not changed since both can be used to provide approximately equivalent levels of fire safety to that required by existing codes.

The full revised guidelines is being republished in this notice.

f. Electrical Guidelines for Residential Rehabilitation: Seven commenters provided detailed comments directed to this guideline. Based on the comments received and a thorough technical review resulting from these comments, the following changes were made:

- The assumptions upon which the guideline is based were restated and clarified, including:
  - the guideline is intended for use only by persons knowledgeable in electrical installations:
  - the guideline stresses retention of as many of the existing components of the electrical system as possible, provided that they assure approximately equivalent levels of electrical safety performance to that intended by existing codes;
  - the guideline is meant to apply whenever current code requirements are triggered or may be used in determining alternate electrical rehabilitation standards.
- The inspection portion of the guideline was made more precise;
- The example in the problem/solution statement regarding the spacing of electrical outlets was deleted and replaced by examples from the BOCA and the City of Detroit codes;
- The apparent emphasis on the use of non-metalic cable was corrected to place equal emphasis on the use of metallic cable and conduit;
- Chapter 10 of the Detroit Electrical Code was added as an appendix to this guideline.

A recommendation that load tests be performed was not adopted because there currently are no reliable standard testing methods available. A

recommendation to disallow second service entrances was not adopted since the alternative of unprotected service wiring was considered more hazardous. A third comment, a recommendation to require wired-in smoke detectors was not adopted since current codes do not require it.

The full revised guideline is being republished in this notice.

g. Plumbing Drain-Waste-Vent (DWV) Guideline for Resdential Rehabilitation Five commenters provided comments directed toward this guideline.

Based on the comments received and a thorough technical review resulting from these comments, the following changes were made:

- The basis for the guideline was restated and clarified, inlcuding:
  - its intended use only by qualified building professionals;
  - its stress on retaining as many of the existing components of the plumbing DWV system as possible, provided that they assure approximately equivalent levels of health performance to that intended by existing codes;
  - its applicability whenever current code requirements are triggered;
- The guideline was rearranged into three parts: (1) determination of existing conditions, (2) problems/solutions, and (3) appendices;
- The use of tests to determine functional performance was amplified;
- References to test data were clarified and expanded;
- Tabular information on the capacity of single stack systems was revised;
- References to several acceptable solutions described in Chapter 16 of Standard Building Code were added;
- Many of the illustrations in the guideline's appendix were clarified and revised;
- Performance criteria mentioned in one of the problem/solution statements were placed in an appendix to the guideline.
- The full revised guideline, with its appendix, is being republished in this notice.

h. Guideline on Fire Ratings of Archaic Materials and Assemblies: Six commenters provided comments directed toward this guideline. Based on the comments received, the following major changes were made:

- Several technical references or descriptions in the introductory text were modified, clarified, or expanded;
- Additional information was added in the introduction regarding Harmathy's second rule;
- The section on "Doors and Door Materials" in the introduction was revised to outline a procedure for technical evaluation, and a case study describing door modifications was added;
- Several minor corrections were made to the fire rating data listed in the appendix.

The use of British terminology, taken from British sources, in the fire rating data was critized. The British sources, however, were not deleted from the fire rating data since most fire experts regard this information as very reliable and not generally available elsewhere.

The guideline's revised introduction, including the section on "Doors and Door Materials," and the added case study on door modification, is being republished in this notice.

Accordingly, the draft Rehabilitation Guidelines published for comment on November 5, 1979 are adopted with the following changes:

Guidelines as Published 44 FR 63760

Page	Column	Line	Changes
●Guideline for setting adopting standards.			Guideline published in this notice replaces draft guideline.
63764	1	First.....	
●Appendix 1 to above guideline			Deleted.
63802	1	First.....	
Appendix 2 to above guideline.....			Deleted.
63809	1	First.....	
Appendix 3 to above guideline.....			Deleted.
63812	1	First.....	
Appendix 7 to above guideline.....			Modified, renumbered to Appendix 3 and republished in this notice.
63848	1	First.....	
(Not included in draft guideline.).....			Appendix 6 added and published in this notice, "State of California Rehabilitation and Repair of Existing Buildings."
(Not included in draft guideline).....			Appendix 11 added and published in this notice, "Rehabilitation of Existing Buildings: An Achievable Goal, reprint from Southern Building Magazine.
●Guideline for municipal approval of building rehabilitation.			Guideline published in this notice replaces draft guideline. "Municipal" deleted from title.
63790	1	First.....	
●Statutory guideline for building rehabilitation.			Guideline has not been modified and will be adopted as published in the draft.
63793		First.....	
●Guideline for managing official liability associated with building rehabilitation.			Guideline has not been modified and will be adopted as published in the draft.
63797	1	First.....	
●Egress guideline for residential rehabilitation.			Guideline published in this notice replaces draft guideline.
63886	2	First.....	
●Electrical guideline for residential rehabilitation.			Guideline published in this notice replaces draft guideline.
63902	2	First.....	
●Plumbing DWV guideline for residential rehabilitation.			Guideline published in this notice replaces draft guideline.
63908	1	First.....	
(Not included in draft guideline.).....			Appendix added containing Plumbing DWV performance criteria.
●Guideline of fire ratings of archaic materials and assemblies.			Guideline published in this notice replaces draft guideline.
63921	2	First.....	
Appendix to above guideline			Appendix has not been modified and will be adopted as published in the draft.
63944	1	First.....	

Findings of inapplicability have been found with respect to the environment and regulatory analysis. Copies of these findings are on file in the Office of General Counsel, Room 5218, Department of Housing and Urban Development, 451 Seventh Street, S.W., Washington, D.C. 20410.

(Sec. 511 of the Housing and Urban Development Act of 1970)

Issued at Washingon, D.C., May 14, 1980.

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GUIDELINE FOR SETTING AND ADOPTING STANDARDS FOR BUILDING REHABILITATION

Table of Contents

Part I. Introduction and Background.
Purpose of the Guideline and Intended Users.
Introduction to the Regulation of Building Rehabilitation: State-of-the-Art.
A. Building Regulations.
B. Implication of Current Regulations for Building Rehabilitation.
C. Historic Preservation.
D. Some Current Regulatory Innovations Related to Building Rehabilitation.
Part II. Identifying Existing Conditions in a Community.
A. Define Existing Regulatory System.
B. Define Pertinent Characteristics of Building Rehabilitation in the Community.
C. Identify Potential Problems.
Part III. Recommendations for Amending or Modifying the Regulatory System to Encourage Rehabilitation.
1. No Modification in Current Regulatory System (25–50% Rule and Change of Occupancy Regulation) Needed.
2. Flexible Application of the 25–50% Rule.
3. Existing Regulatory System, in Its Relation to Building Rehabilitation, Is in Need of Modification.
4. A Definition of Imminent Hazards Is Needed in the Regulatory System.

Appendices.
Bibliography.

PART I

INTRODUCTION AND BACKGROUND

Purpose of the Guidelines and Intended Users

Purpose

This guideline is intended to serve the following purposes:

(1) To present a method for describing and analyzing the existing regulatory system affecting all buildings (existing and new) in a community. This method includes identification of all pertinent codes and regulations, as well as all departments involved in their enforcement.

(2) To present a method for assessing the impact of standards set by the existing regulatory system on building rehabilitation in the community, and for identifying problems and constraints for rehabilitation.

(3) To recommend methods for amending or modifying the existing regulatory system so as to establish and enforce standards which encourage rehabilitation.

Intended Users

The following groups or individuals may use this guideline:

(1) Citizen groups (voluntary or appointed) who wish to assess the impact of the building regulatory system on rehabilitation in their community.

(2) Policymakers in city government (mayor, council, city manager, community development director, etc.) who wish to assess the impact of the existing building regulatory system on rehabilitation, and/or to amend or modify it in order to encourage rehabilitation.

(3) Code enforcement department heads (building officials) who wish to assess the need for amendment or modification of the existing building regulatory system in order to encourage rehabilitation.

Definitions

This guideline does not start off with a precise definition of "rehabilitation" and other related terms. This is intentional, because the nature of building rehabilitation which may encounter regulatory problems and constraints, and the nature of the problems themselves, are a local phenomenon. Thus, a community using this guideline may evolve its own definition of "rehabilitation", which could include any specific set of activities related to the general view of existing buildings as a resource to be conserved, rehabilitated or reused in the community's ongoing development process. What is important for the users of this guideline to realize is that there are many different kinds of rehabilitation projects and many different kinds of code-related problems, and that this and the accompanying guidelines could be useful in dealing with most of them.

INTRODUCTION TO THE REGULATION OF BUILDING REHABILITATION: STATE-OF-THE-ART

A. Building Regulations

In order to adapt or modify a jurisdiction's existing building regulatory system so as to promote rehabilitation, particularly residential rehabilitation, or in order to minimize the constraints which that system may impose on rehabilitation projects, it is first necessary to understand the building regulatory system in general terms and how that system regulates existing buildings.

A.1 How the Building Construction and Maintenance Regulatory System Regulates Existing Buildings

Communities or other jurisdictions (e.g., states) currently regulate new and existing buildings by one or more of the following five types of regulations:

- Construction codes.
- Building maintenance codes (property maintenance/housing/health/fire prevention).
- Hazard abatement codes.
- Past construction codes.
- Retroactive laws and regulations.

(1) *Construction codes.* Construction codes are generally referred to as "building codes". Actually they include a building code (regulation structural, fire, accident and health safety aspects of building), an electrical code, a plumbing code, a mechanical code and a variety of specialty codes controlling such elements as boilers, elevators, etc.

The objectives of these codes is to provide certain levels of safety, health, welfare and property protection for building occupants and for the general public. To accomplish this they regulate design, construction, repairs, use, maintenance, moving, and demolition of buildings, or portions thereof.

Building codes often provide two approaches to compliance: prescriptive and performance. The relevance of this distinction to rehabilitation will be discussed later. Codes prescribe acceptable materials, sizes and methods of construction. However, most modern building codes also provide a performance approach by providing for the acceptance of alternate materials and methods of construction. The following sections of the Uniform Building Code (UBC), Standard Building Code (SBC), Basic Building Code (BBC) and National Building Code (NBC) define this approach:

Uniform Building Code—1979 Edition

"Alternate Materials and Methods of Construction. Sec. 105. The provisions of this code are not intended to prevent the use of any material or method of construction not specifically prescribed by this code, provided any alternate has been approved and its use authorized by the building official.

"The building official may approve any such alternate, provided he finds that the proposed design is satisfactory and complies with the provisions of this code and that the material, method or work offered is, for the purpose intended, at least equivalent of that prescribed in this code in suitability, strength, effectiveness, fire resistance, durability, safety and sanitation.

"The building official shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use. The details of any action granting approval of an alternate shall be recorded and entered in the files of the code enforcement agency."

Standard Building Code—1979 Edition

"103.6 Alternate Materials and Alternate Methods of Construction. The provisions of this code are not intended to prevent the use of any material, or method of construction not specifically prescribed by this code, provided any such alternate has been approved and its use authorized by the Building Official. The Building Official shall approve any such alternate, provided he finds that the proposed design is satisfactory and complies with the provisions of Chapter XII, and that the material, method, or work offered is, for the purpose intended at least the equivalent of that prescribed in the code in quality, strength, effectiveness, fire resistance, durability, and safety. The Building Official shall require that sufficient evidence or proof be submitted to substantiate any claim that may be made regarding its use. If, in the opinion of the Building Official, the evidence and proof are not sufficient to justify approval, the applicant may refer the entire matter to the Board of Adjustments and Appeals as stipulated in Section 111."

The BOCA Basic Building Code—1978

"109.4 Alternate Materials and Equipment. The provisions of this code are not intended to prevent the use of any material or method of construction

not specifically prescribed by this code, provided any such alternate has been approved. The building official may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety."

National Building Code—1976

"100.7 Materials and Methods of Construction. Nothing in this Code shall be construed to prevent the use of any material or method of construction whether or not specifically provided for in this Code if, upon presentation of plans, methods of analysis, test data or other necessary information, to the building official by the interested person or persons, the building official is satisfied that the proposed material or method of construction complies with specific provisions of or conforms to the intent of this Code."

Such provisions provide local officials with a significant potential for flexibility, which can be used to encourage building conservation, rehabilitation and reuse, or to reduce constraints thereto, when existing buildings cannot easily comply with the prescriptive requirements of the codes. Traditionally, however, the "alternate materials and methods" approach has been used for approval of new products where the basis for acceptance is reasonably clear. It has been used to a much lesser degree for the acceptance of alternate design methods for meeting the intent of the code which is often the problem in building rehabilitation. There are two reasons for this: First, there is no general agreement on what is covered by the terms "materials and methods of construction." For example, some interpret these to include dimensions specified in the code (e.g., stair widths), while others consider such specifications as "design specifications" to be excluded from "materials and methods." Second, while the model codes all contain a general statement of purpose at their outset, they lack clear statements of "code intent" for the several building attributes regulated (e.g., structural safety, fire safety, accident safety, health and hygiene), and for most specific code provisions.

Building codes often give the enforcement official authority to modify code provisions in individual instances, when practical difficulties in full compliance are involved. While this modification authority provides the official with opportunity to exercise judgment, it is not adequate for use as a general vehicle for the encouragement of building conservation, rehabilitation and reuse.

Construction codes may be adopted at the state or the local level, depending on state law. The various specialty codes (building, electrical, plumbing, etc.) may be enforced by one agency or by various agencies of government. These options may have significant impact on building regulation in general, and on building conservation, rehabilitation and reuse in particular.

The enforcement of provisions of construction codes is usually triggered by an application for a permit (building, electrical, plumbing) to construct.

Construction codes are periodically updated. The model codes, which are adopted by many jurisdictions, are updated and republished every three years, with amendments published periodically between each new edition. The updating of codes involves five types of code modification:

- Elimination of references to materials and methods of construction no longer used in modern construction (i. e., "archaic" materials and methods).
- Addition of reference to new materials and methods of construction.
- Addition of new requirements.
- Modification of administrative provisions.
- Change in required levels of performance.

It is believed that, in general, the updating of codes represents a constant increase in the specified levels of safety, health, welfare, and property protection. While this statement is in need of proof, and while notable instances of reduction in codes change periodically in response to changing technology, new materials and products, and the changing needs of building occupants and the community at large. A building constructed to a past building code is not likely to meet all provisions of the current code.

Building codes regulate building rehabilitation and reuse in several ways, which are discussed in Section B. of this part.

(2) *Building Maintenance Codes (Property Maintenance/Housing/ Health/Fire Prevention).*

The basis for adopting property maintenance codes is contained in the building codes. The three model building codes, and nearly all other modern building codes, contain sections which require that all building, built under current or previous codes be maintained in a safe and sanitary condition.

It is apparent that building codes requiring maintenance and repair allow repairs to be made in a manner consistent with the original construction system. Where materials are no longer available (wood lath for example) a modern-day counterpart can be used.

Maintenance essentially means that the structural, fire, and health and safety features of a building be maintained at levels comparable to those existing at the time the building was constructed.

Communities may regulate existing buildings by means of property maintenance codes. Most widely used of these are housing (or health) codes. Housing codes have traditionally been used for establishing minimum levels of health in existing residential occupancies (one and two family dwellings, apartments and hotels). Property maintenance codes contain the requirements of the housing code plus requirements applicable to other occupancies. Housing codes contain many specific requirements, while property maintenance codes tend to be more performance based (containing general statements of objectives).

Fire preventiuon codes are also a form of property maintenance code. They are intended to control the fire hazards in buildings by proper operation and maintenance procedures.

Housing codes and fire prevention codes are adopted either by the state or local government. They are often enforced by a different agency from that charged with enforcing the building code. The enforcement of these codes is usually triggered by complaints and by routine periodic inspections (the latter often concentrating on selected occupancies or selected neighborhoods). In some communities, the enforcement of these codes may also be triggered by periodic license or permit requirements (e.g., business license, fire marshal's permit, etc.). It is likely that in many communities there is a significant number of buildings which do not comply with the housing and/or fire prevention codes, due to the limitations on resources available for routine inspection of all buildings. Often, housing code enforcement is done by persons with special sensitivity to the needs of residents—a feature which may be of potential benefit for the encouragement of building conservation, rehabilitation and reuse.

General property maintenance codes are usually adopted by local government, since they are applicable to any occupancy. However, their adoption is not widespread.

Housing codes and property maintenance codes cover many of the same attributes of buildings regulated in new construction codes. For these same attributes, however, they usually

establish levels of health, safety and welfare which are lower than the respective levels established by the new construction codes. The actual levels established by the maintenance codes are not usually stated as explicitly, as in construction codes.

The enforcement of housing and property maintenance codes often becomes the basis for mandatory repairs (see Section B below) in existing buildings. However, by providing a baseline level of health and safety for existing residential and/or other buildings, these codes may be employed to encourage building conservation, rehabilitation and reuse.

(3) *Hazard Abatement Codes.* Codes for the Abatement of Dangerous Buildings, or similarly titled documents, provide a basis for measuring or evaluating the condition of an existing building. These codes very carefully provide for due process to ensure that the enforcing body acts legally when it deems a building to be dangerous and requires its repair, evacuation, or demolition.

Both the International Conference of Building Officials (ICBO) and the Southern Building Code Congress International (SBCCI) publish a code for the Abatement of Dangerous Buildings. The Building Officials and Code Administrators International (BOCA) includes similar provisions within the Basic Building Code.

These codes include fairly easily implemented provisions for structural analysis, and give specific limits for material stresses. The requirements for fire safety, accident and health generally refer back to the code under which the building was built, and address how the required building safety elements are currently operating and are maintained. These requirements are stated in general performance language.

Hazard abatement codes have traditionally been used as the means to secure demolition of buildings. Their enforcement is usually triggered by complaints, inspections or any other actions which bring the potential hazard to the attention of the authorities.

These codes establish levels of safety and health which are lower than those established in building codes for new construction. It may be implied that these levels are also lower than those of property maintenance codes.

Implied in all building regulations, and in hazard abatement codes, is the concept of "imminent hazard". This is the absolute lowest level a building can reach. The discovery of an "imminent hazard" in a building will justify drastic enforcement without permitting any delay in correction. While not specifically defined in the codes, a guideline for determining "imminent hazard" is included in Part III of this Guideline.

(4) *Past Construction Codes.* As discussed earlier, the implication contained in most building codes and property maintenance codes is that the minimum requirement for an existing building is that the building, and any required safety equipment and devices, be maintained to the level required by the code under which the building had been constructed. As discussed earlier, these past codes establish levels of health, safety, welfare and property protection which are different from, and are usually lower than, those of current new construction codes.

(5) *Retroactive Laws/Regulations.* In some cases States or local governments have declared certain building features unsafe, or otherwise undesirable, and have required that all buildings of a certain occupancy or class be altered to remove the unsafe or undesirable condition, or to install some specific feature making the building appropriately safe or desirable.

Examples of such retroactive regulations are:

- High-Rise Requirements Adopted by the California State Fire Marshal.
- City of Los Angeles Stairway Enclosure Requirements for Hotels, Apartments and Similar Residential Buildings Exceeding Two Stories in Height.
- City of Los Angeles Preliminary Draft of "Earthquake Hazard Reduction in Existing Buildings," currently being considered for adoption. This draft deals potentially with all building occupancies, reclassifying them into four hazard classifications.
- Appendix Chapter 12 of the 1979 Uniform Building Code, "Existing Buildings". This chapter is applicable to existing nonconforming Group R, Division 1 occupancies (hotels, apartment houses, convents and monasteries) more than two stories in height. (See Appendix 1 of this guideline.)

In all cases, existing buildings covered by the retroactive regulations are required to be modified to conform to the new minimum provisions. The levels of health, safety, welfare and/or property protection required by such retroactive regulations may be the same as, or lower than, the respective levels required by codes for new construction.

The enforcement of a retroactive regulation is triggered by inspections called for by the regulation itself. Often the enforcement is constrained by the commmunity's available resources, in which case the community may establish a schedule for enforcement based on neighborhood location, type of building or other factors.

A.2 Continued Use and Occupancy—Building Codes and Existing Buildings

Building codes traditionally permit the continued use and occupancy of buildings in existence at the time of the adoption of the code. This is often referred to as the "non-conforming rights" of existing buildings. Section 104(c) of the 1979 edition of the Uniform Building Code is a case in point:

"Existing Occupancy. Buildings in existence at the time of the adoption of this code may have their existing use or occupancy continued, if such use or occupancy was legal at the time of the adoption of this code, provided such continued use is not dangerous to life."

Section 105.1 of the 1978 edition of the Basic Building Code reads as follows:

"Continuation of existing use: The legal use and occupancy of any structure existing on ——— (date of adoption of this code) or for which it has been heretofore approved, may be continued without change, except as may be specifically covered in this code and the housing code or as may be deemed necessary by the building official for the general safety and welfare of the occupants and the public."

Similar code sections occur in other modern building codes used throughout the United States. Accordingly, in order to mandate that an existing building be repaired or brought up to some minimum condition of safety, one of three possibilities exists:

- establish that a building is dangerous in accordance with a hazard abatement code or similar regulation;
- enforce a property maintenance code; or
- enforce a retroactive law or provision.

A.3 Levels of Health, Safety, Welfare and Property Protection

The preceding discussion has alluded to the various levels of health, safety, welfare and property protection implied by the varioius codes and regulations being discussed—with new construction codes defining the highest, and hazard abatement codes defining the lowest. It may be useful for communities considering setting or adopting standards for building rehabilitation to formalize this concept of levels of performance required by the various codes and regulations.

For each major objective of codes—health, safety, welfare, and property protection—one can conceive of a scale of performance. New construction code

requirements may be thought of as generally defining the upper limits of such a scale; hazard abatement codes may be thought of as defining the lower limits of such a scale (with "imminent hazards" being specific points below or at the lower limit). Property maintenance codes and past building codes may be viewed as occupying given points between those limits. This concept is shown in diagram 1.

An existing (legal) building may be thought of as embodying levels of health, safety, welfare and property protection anywhere between these limits or above the upper limit. Retroactive laws and regulations may mandate the upgrading of such a building to some specified level (with regard to a specific code objective or attribute). However, when such a building is rehabilitated, the existing set of regulations, as discussed earlier, will explicitly or implicitly require that building to reach a specified new level. The following section of this Part (Section B) discusses how this new level of performance is currently specified by building regulations.

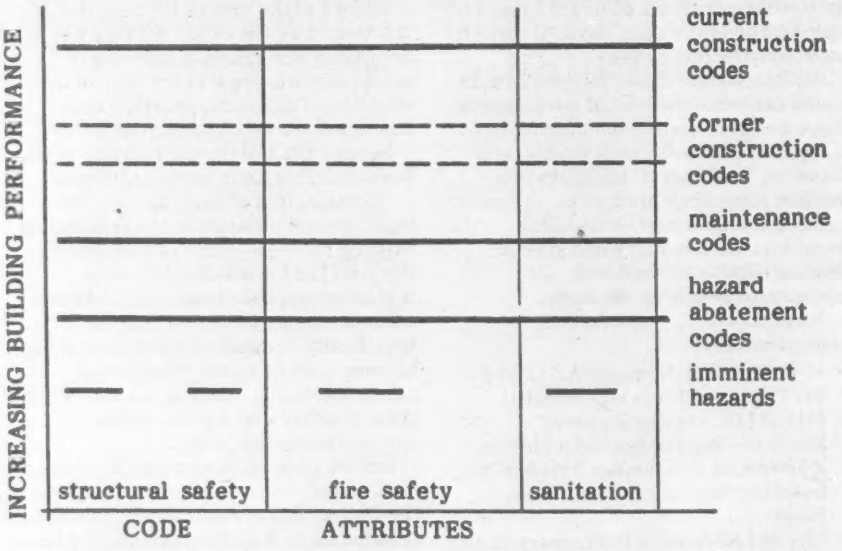

Diagram 1.
Conceptual Diagram of Various Levels of Building Performance Implied by Various Types of Building Regulations

While this concept of "levels" may be useful in considering building rehabilitation, it should be kept in mind that it may not be possible to actually quantify or measure a given level, or the difference between levels (e.g., egress potential of current codes and older codes).

Finally, for every level which is specified by a set of code requirements, the "alternative materials and methods" provision of modern building codes (as discussed earlier) recognizes that a given level can be achieved by alternatives to compliance with the code requirements. Such alternatives achieve equivalent performance. It is essential to make a clear distinction between equivalent performance (achieved by alternative means) and reduced performance.

B. Implication of Current Regulations for Building Rehabilitation

B.1 Current Regulations and Building Rehabilitation

In general, building codes address building rehabilitation in two categories:

- Maintenance, alteration and repair of existing buildings not involving a change of use or a change of occupancy.
- Change of use or occupancy in existing buildings.

(1) *No Change of Use or Occupancy (25–50%).* Rehabilitation work involving no change of use or occupancy can be further qualified into two distinct categories:

- Voluntary maintenance, alterations or repairs (modernization, upgrading, etc.).
- Mandatory maintenance, alterations or repairs.

Voluntary repairs or maintenance of a building and its facilities involves work which is to conform to the code under which the building was initially constructed. The idea and action are voluntary. Rehabilitation work in this category is in general included in the building's non-conforming rights under the building code, although it may trigger the correction of a host of violations considered hazardous which are unrelated to the voluntary work. It may also trigger degrees of compliance with new construction codes through the 25–50% Rule to be discussed below. Whatever requirements are imposed, their enforcement is triggered, in this case, by an application for a construction permit (building, electrical, plumbing, etc.).

Mandatory repair or maintenance results in a building and its facilities being required to comform to a level of safety as defined by law (codes for the abatement of dangerous buildings, property maintenance codes, housing codes, and/or specific retroactive provisions). The applicant may be given a period of time to comply. The idea and action are mandatory. Rehabilitation work in this category may trigger degrees of compliance with new construction codes through the 25–50% Rule.

Commonly, building codes control rehabilitation with no change of use by means of the 25–50% Rule.

According to research done by the National Conference of States on Building Codes and Standards (NCSBCS), the 25–50% Rule first appeared in building codes as part of provisions dealing with fire districts and was applied to buildings which were non-conforming within the fire district. As population and usage density increased in urban areas and several fire disasters occurred, communities became increasingly aware of the danger of fire literally consuming whole areas of a city where many buildings were of wood frame construction. The criterion of 50% of value was used to require demolition, or replacement of frame exterior walls with conforming construction. In other words, according to this research, the original purpose of the rule was to *prevent* rehabilitation of certain classes of buildings.

The actual wording of the 25–50% Rule in the four model codes is contained in the following sections:

- Basic Building Code, Section 106.0
- Standard Building Code, Section 101.4
- Uniform Building Code, Section 104
- National Building Code, Section 104.3

In the 1979 edition of UBC, Section 104 has been revised to drop all references to cost of rehabilitation. For the purposes of the following discussion, reference to the UBC version will be to the 1976 edition, since many jurisdictions are still using this edition. There are certain similarities and differences among the four versions which should be noted.

a. Over 50%. The BOCA Basic Building Code (BBC), the SBCCI Standard Building Code (SBC), and the 1976 edition of the ICBO Uniform Building Code (UBC) all contain the basic 25–50% Rule. The American Insurance Association (AInsA) National Building Code (NBC) contains reference only to restoration if cost exceeds 50%. All four of the codes are consistent in requiring that the entire building be brought into compliance with current code requirements if the cost of the work exceeds 50% of the value of the building. The NBC apparently does not administratively address the issue if restoration costs are below 50% of value. Hence, the balance of this discussion is primarily directed to the three remaining model codes.

Both the BBC asnd SBC state that the physical value of the building will be determined by the building offical. The BBC also states the value will be based on replacement cost.

All three models indicate that the rule applies only if the alteration or repairs are made within a 12-month period.

BBC and SBC differentiate between alterations exceeding 50% and repair of damages exceeding 50%. The 12-month period does not apply to the repair of a building damaged in excess of 50% in value.

b. Between 25–50%. Where the cost of the alteration is between 25 and 50% of value of the building, both BBC and SBC specify that the extent to which the portion of the building altered or repaired be made to conform to new construction requirements is left to the discretion of the building official. The UBC (1976 edition) states that the addition, alteration or repair be made in conformance with the current code, provided that the entire building not exceed areas and heights specified by the code.

c. Under 25%. Where the cost of the alteration if under 25%, BBC and SBC essentially allow restoration with like materials with caveats that the public safety is not endangered or a non-conforming or hazardous use is not extended.

In the under 25% category, the UBC (1976 edition) distinguishes between structural and non-structural alterations. For structural alterations, the changes must conform to new code requirements, unless they are minor, in which case the building official may approve replacement with like materials, provided that the entire building not exceed areas and heights specified by the code. Non-structural alterations and repairs can be made with like materials provided they do not affect any member or part of the structure having required fire resistance.

Jurisdictions that use the 25–50% Rule at times vary the terms from those in the model codes. Two examples are Los Angeles and Phoenix.

Los Angeles may be said to have a 10-50% rule, related to location with respect to fire districts. The Building Code of the City of Los Angeles, 1976 edition states:

"Sec. 91.0103—Application to Existing Building

* * * * *

(d) Alterations. Any alterations may be made to any building in any location provided the building as altered conforms to the requirements of the Los Angeles Municipal Code for new buildings in the same location.

Exceptions: 1. Alterations or repairs to any existing non-conforming building outside of every Fire District may be of the same type of construction as the existing building, provided the aggregate value of such alterations or repairs in any two-year period does not exceed 50 per cent of the replacement value of the building.

2. Alterations or repairs may be made to any building in any location provided the new construction conforms to that required for a new building of like area, height and occupancy in the same location."

"Sec. 91.1603—General Requirements

* * * * *

(b) Nonconforming Buildings. Alterations and repairs to a nonconforming building in a Fire District may be of the same type of construction as the existing building if the aggregate value of such repairs, in any one year, does not exceed 10% of the replacement cost of the building.

Alterations or repairs in excess of 10% of the replacement cost of the building or structure may be made provided all of the repairs and the new construction conform to the materials and type of construction required for a new building of like area, height and occupancy in the same location.

Whenever a nonconforming building or structure has been damaged, or is in need of repairs or alterations required by the Los Angeles Municipal Code in an amount exceeding 50% of the replacement cost, the entire building or structure shall be made to conform to the Code or shall be demolished."

The City of Phoenix, Arizona, briefly reported the following information:

If Cost of Repair is:
0–10%—Replace with like material
10–50%—New work must meet code
Over 50%—Entire building must meet code

In summary, the 25–50% Rule requires the upgrading of existing buildings to the performance levels required for new construction if work exceeds 50%, and allows various lower levels to continue to exist in buildings when lesser work is involved. It should be noted that the "alternate materials and methods" provisions of building codes, while generally applicable to *all* provisions of the codes, is not explicitly referenced in relation to compliance with the 25–50% Rule.

The 25–50% Rule has been the target of much criticism with regard to its effects on building conservation, rehabilitation and reuse. This criticism is underlined by the fact that originally the Rule was not intended to deal with rehabilitation. The drawback of the 25–50% Rule is that it is arbitrary, and it may unintentionally or by default force a rehabilitated building into complete new construction code compliance, when the 50% is exceeded. Furthermore, the 25–50% Rule has an adverse effect on the rehabilitation of buildings of a low value, and may discriminate between similar buildings located in different real estate markets.

In terms of the conceptual diagram of performance levels discussed in A.3 above, the 25–50% Rule requires rehabilitated buildings to be upgraded to three potentially different levels of performance.

While the 25–50% Rule may be eliminated from all the model codes in the foreseeable future, it is currently found in many local codes. It should be noted that when used in close conjunction with the "alternate materials and methods" provision, and when applied to the lower range of values, the Rule is often seen as a flexible tool for the encouragement of rehabilitation, by explicitly extending the building's non-conforming rights. As such, it will be discussed later in this guideline.

As stated previously, ICBO has eliminated the 25–50% Rule from the 1979 edition of the UBC and substituted the following wording:

"Application to Existing Buildings and Structures. Sec. 104. (a) General.—Buildings and structures to which additions, alterations or repairs are made shall comply with the requirements of this code for new facilities except as specifically provided in this section. See Section 1210 for provisions requiring installation of smoke detectors in existing Group R, Division 3 Occupancies.

(b) Additions, Alterations or Repairs.—Additions, alterations or repairs may be made to any building or structure without requiring the existing building or structure to comply with all the requirements of this code provided the addition, alteration or repair conforms to that required for a new building or structure. Additions, alterations or repairs shall not cause an existing building or structure to become unsafe or overloaded. Any building so altered, which involves a change in use or occupancy, shall not exceed the height, number of stories or area permitted for new buildings. Any building plus new additions shall not exceed the height, number of stories and area specified for new buildings.

Alterations or repairs to an existing building or structure which are nonstructural and do not adversely affect any structural member or any part of the building or structure having required fire resistance may be made with the same materials of which the building or structure is constructed.

Exception: The installation or replacement of glass shall be as required for new installations."

In essence, the 1979 UBC Section 104(b) now requires that for additions, alterations, or repairs:

- new work must conform to the code,
- work shall not cause existing buildings to become unsafe or overloaded,
- altered buildings involving change in use or occupancy, and buildings undergoing addition, shall not exceed height and area required for new buildings, and
- non-structural work not adversely affecting a structural member or any part having required fire resistance may be done with same materials.

As compared to the former Sections 104(b) through 104(e) (25–50% Rule) the new section appears to accomplish the following:

- Any amount of non-structural work can now be done with like materials, as compared to work amounting to 25% or less under the prior rule;
- Any new structural work must be in conformance with current code (which constitutes no change from the prior rule in the 0–50% bracket),

- With the caveats noted regarding overloading and height and area restrictions, the existing structure can remain without being brought up to new code requirements.

This UBC substitution for the 25–50% Rule requires the upgrading of rehabilitated buildings to a performance level somewhat lower than that required for new construction, while requiring new construction performance for specifically defined aspects.

A similar substitution to the 25–50% Rule was recommended by the BOCA Code Change Committee in January, 1980, and will be voted on by the BOCA membership in June, 1980.

(2) Change of Use or Occupancy. Building codes address change of use or occupancy in existing buildings by considering that such a change may introduce new or greater hazards and by requiring a careful reexamination to determine that the building will be safe for the new occupancy.

The three model building codes require, generally, that where a change in occupancy occurs, the building must be made to comply with the requirements of the current building code for the new occupancy. The model codes state this in various ways.

The 1978 BOCA Basic Building Code addresses change of use in three sections:

"105.2 Change in use: It shall be unlawful to make any change in the use or occupancy of any structure which would subject it to any special provision of this code without approval of the building official, and his certification that such structure meets the intent of the provisions of low governing building construction with a proposed new use and occupancy, and that such change does not result in any greater hazard to public safety or welfare."

"119.2 Buildings hereafter altered: A building or structure hereafter enlarged, extended or altered to change from one use group to another or to a different use within the same use group, in whole or in part, and a building or structure hereafter altered for which a certificate of use and occupancy has not been heretofore issued, shall not be occupied or used until the certificate shall have been issued by the building official, certifying that the work has been completed in accordance with the provisions of the approved permit; except that any use or occupancy, which was not discontinued during the work of alteration, shall be discontinued within thirty days after the completion of the alteration unless the required certificate is secured from the building official."

"119.4 Changes in use and occupancy: After a change of use has been made in a building or structure, the reestablishment of a prior use that would not have been legal in a new building of the same type of construction is prohibited unless the building complies with all applicable provisions of this code. A change from one prohibited use, for which a permit has been granted, to another prohibited use shall be deemed a violation of this code."

Section 101.4(e) of the 1979 Standard Building Code states:

"If the occupancy of an existing building is entirely changed the building shall be made to conform to the requirments of this code for the new occupancy. If the occupancy of only a portion of an existing building is changed and that portion is separated from the remainder as stipulated in Section 403, then only such portion need be made to conform."

Section 502 of the 1979 Uniform Building Code states in part:

"No change shall be made in the character of occupancies or use of any building which would place the building in a different division of the same group of occupancy or in a different group of occupancies, unless such building is made to comply with the requirements of this code for such division or group of occupancy.

Exception: The character of the occupancy of existing buildings may be changed subject to the approval of the building official, and the building may be occupied for purposes in other groups without conforming to all the requirements of this code for those groups, provided the new or proposed use is less hazardous, based upon life and fire risk than the existing use."

The SBC unambiguously requires compliance with current code provisions. The UBC is similar, but includes the *Exception* which waives compliance with *all* current code provisions (i.e., requires compliance with *some* only). The *Exception* is in performance language, and the enforcment official must determine whether the proposed use is less hazardous based on life and fire risk than the existing use. The UBC does not define "life and fire risk". A decision must be made whether it was intended to apply to property damage as well as to life safety of the occupants.

The BBC appears to give the enforcement official the greatest leeway (of the three model codes) in determining the extent to which compliance with current code provisions would be required.

In summary, the model codes vary in their requirements for rehabilitation involving a change in use or occupancy. At one extreme they require upgrading to the performance levels of new construction. At the other, they require selective upgrading, based on undefined hazard and risk analyses. Here also, as in the case of the 25–50% Rule, explicit reference to the "alternate materials and methods" provision in cases of change or use or occupancy is not made.

B.2 "Code Enforcement Guidelines for Residential Rehabilitation", Published by BOCA

The document, entitled "Code Enforcement Guidelines for Residential Rehabilitation", the first edition of which was published in 1975, was developed by BOCA, ICBO, SBCCI and AInsA on the basis of research sponsored by the U.S. Department of Housing and Urban Development.

The document is currently published as Appendix B to the 1978 BOCA Basic Property Maintenance Code.

The extent and nature of the application of this document to residential rehabilitation in local communities is not known at this time.

B.3 Possibility of Conflicting Goals of Regulations and Rehabilitation

Building regulations, as discussed earlier, are intended to implement goals of private and public health, safety, welfare and property protection in the occupancy and use of buildings. These goals are usually not explicitly stated by a community. Their achievement through the enforcement of building regulations imposes certain costs on building owners and on society.

Programs of building conservation, rehabilitation and reuse are also initiated by communities in the furtherance of certain goals. These goals may relate to avoiding the reduction of the existing housing stock, or to preventing the deterioration of downtowns or of industrial areas.

It is useful for a community to realize, whether explicitly or implicitly, that the goals of its rehabilitation and community development program may conflict with the goals underlying its current building regulation program. In such a case, the enforcement of building regulation will not support the community's rehabilitation goals. Specifically, current building regulation may force the upgrading of rehabilitated buildings to the levels required for new construction (as discussed above), which may impose an unacceptable cost on rehabilitation and may prevent rehabilitation from taking place.

If a community finds that its regulation and rehabilitation goals are potentially in conflict, it may determine that in the interest of furthering

rehabilitation, some reduction in the levels of performance (safety, health, welfare and/or property protection) required of rehabilitated buildings may be acceptable. A community which develops a rehabilitation policy on the basis of such a determination will find the concept of the various levels of performance introduced in A.3 above useful in implementing such a policy. The concept may help the community to set specific standards and requirements for rehabilitation that are different from the regulation currently in effect.

Such standards and requirements may imply lower levels of performance than required for new construction, while reflecting acceptable levels of safety for the community.

The following diagram illustrates the levels of performance of a specific existing building, in relation to the performance level required by various regulations in effect. It suggests the potential benefits of establishing specific requirements for building rehabilitation, because in their absence the current 25–50% Rule and change of occupancy provisions often force the building up to the performance levels of the new construction codes.

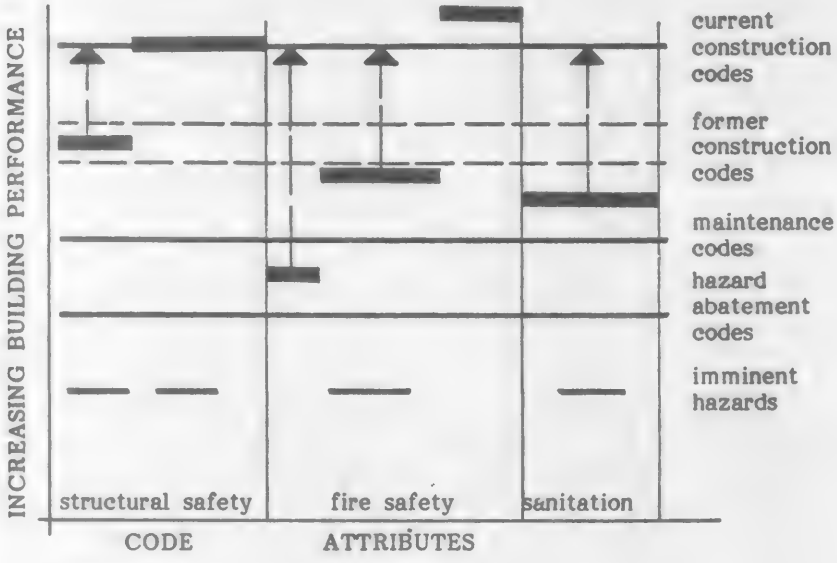

Diagram 2.
Conceptual Diagram of the Extent of Rehabilitation Work (Indicated by Arrows) Imposed on an Existing Building by Current 25-50% Rule and Change of Occupancy Provisions. (Each bar represents a special building component such as DWV system, stairs, structure, etc.)

C. Historic Preservation

A discussion of the state-of-the-art of regulation of building rehabilitation would not be complete without mentioning historic preservation. Historic preservation is a specific problem, and in addressing it the building regulatory system has accepted the fact that in achieving the policy goals of historic preservation, some compromise with the health and safety goals of the regulatory system may be required. This compromise has been recognized by the model code groups.

The 1978 BOCA Basic Building Code States:

"Section 316.0 Special Historic Buildings and Districts. 316.1 Approval: The provisions of this code relating to the construction, repair, alteration, enlargement, restoration and moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state and/or local government authority as historic buildings, subject to the approval of the board of appeals when such buildings are judged by the building official to be safe and in the public's interest of health, safety and welfare regarding any proposed construction, alteration, repair, enlargement, relocation, and location within the fire limits. All such approvals must be based on the applicant's complete submission of professional architectural and engineering plans and specifications bearing the professional seal of the designer."

Section 104.(f) of the 1979 Uniform Building Code states, similarly:

"(f) Historic Buildings. Repairs, alterations and additions necessary for the preservation, restoration, rehabilitation or continued use of a building or structure may be made without conformance to all of the requirements of this code when authorized by the building official provided:

1. The building or structure has been designated by official action of the legally constituted authority of this jurisdiction as having special historical or architectural significance.

2. Any unsafe conditions as described in this code are corrected.

3. The restored building or structure will be no more hazardous based on life safety, fire safety and sanitation than the existing building."

Briefly, buildings may be exempted from full code compliance either individually, as a landmark, or collectively in an historic district. The designation as a landmark or as an historic district may be made by local public landmarks/historic district commissions, and may rely to varying degrees on state historic preservation offices or on listing in the National Register of Historic Places, maintained by the Heritage Conservation and Recreation Service of the U.S. Department of the Interior.

D. Some Current Regulatory Innovations Related to Building Rehabilitation

Several specific examples of direct approaches to the regulation of building rehabilitation, rather than the building codes' indirect approach through the 25–50% Rule and the change of occupancy regulations are discussed briefly below. Fuller discussions and documentation of each example are included in the Appendices.

All the examples establish a set of requirements applicable to rehabilitation, and each, to varying degrees, reflects a reduction from the total set of requirements applicable to new construction. In other words, each example is a regulatory innovation which addresses the problem of setting standards for rehabilitation, and may be thought of as requiring a level of performance below the upper level implied by codes for new construction (see A.3 above).

Each regulatory innovation is likely to have grown or evolved out of a very specific set of physical and social conditions, and to have been intended to solve specific local problems.

The following examples of regulatory innovation are suggested for consideration; they are not intended to form an exclusive or comprehensive list, and similar regulatory innovations may exist elsewhere:

- Washington, D.C. (Appendix 2)
- San Francisco, California (Appendix 3)
- Denver, Colorado (Appendix 4)
- State of Massachusetts (Appendix 5)
- State of California (Appendix 6)
- City of Los Angeles Rule of General Application on Structural Changes Required by Change of Occupancy (Appendix 7)
- State of California Seismic Safety Commission Draft Legislation Related to Seismic Hazards (Appendix 8)
- Chapter 10 of the Official Electrical Code of the City of Detroit (Appendix 9)

The examples fall into two categories:

- Comprehensive approaches
- Partial approaches

D.1 Comprehensive Approaches

Examples of comprehensive approaches can be found in Washington, D.C.; San Francisco, California; Denver, Colorado; the State of Massachusetts. These approaches are comprehensive because each one of them has developed an innovative regulatory system which addresses all aspects of rehabilitation of buildings in most, or all, occupancies, with the exception of Massachusetts, which does not address electrical, mechanical and plumbing requirements.

(1) *Washington, D.C.* Washington's code includes neither the 25–50% Rule nor the general change in use regulations. In their place, the code contains prescriptive provisions specifically addressing existing buildings, and specific provisions applied when a change in use occurs. In

general, the code requires several levels of performance in increasing order:

(a) Code in effect when building was erected
(b) Retroactive provisions
(c) Provisions concerning alteration or conversion
(d) Provisions for new construction.

The code incorporates a hazard ranking by occupancy type and intensity of use. Conversion is defined as a change to a higher hazard use. Alteration is defined as work which affects egress arrangements or fire resistivity.

The code provisions were developed over a long period of time, and are based on the approach of allowing certain deviations from the requirements for new construction for existing, altered or converted buildings. The text of these provisions is provided in Appendix 2.

Prescriptive requirements for rehabilitation may be effective in an urban jurisdiction such as Washington, D.C. where the building official may be familiar with a large number of older buildings, which pose similar problems for rehabilitation. Additional prescriptive requirements may be needed to cover the range of rehabilitation problems encountered in jurisdictions with a more varied or diverse building stock.

(2) *San Francisco, California.* San Francisco's code, like Washington's, includes neither the 25–50% Rule, nor the general model code change in use provision.

San Francisco handles rehabilitation and change in use be establishing three separate approaches. These are:

- For existing residential building rehabilitation: using the San Francisco Housing Code (SFHC) together with a "Field Inspection Manual" (FIM).
- For any change in use or occupancy: using the San Francisco Building Code (SFBC) which includes a series of criteria which may lessen the specific application of new construction standards.
- For general alterations, additions and extensions, regardless of use or occupancy: setting specific criteria for the amount and type of work that may be done before requiring full compliance with present code provisions.

These separate approaches are discussed at greater length with all code references in Appendix 3.

(a) The underlying principle for the rehabilitation of existing residential buildings is that existing buildings, legally constructed at some time in the past, shall be considered acceptable today unless they do not conform to a specific list of retroactive requirements. (Sections 105 and 309 SFHC and Introduction to FIM.)

These requirments include items related to health and safety such as unenclosed stairways, exits, fire alarms, etc. The provisions in the SFHC are less strict than those required for new construction in the SFBC. For example, acceptance of smoke barriers (non-rated construction) for stairway enclosures which by SFBC would have to be 1 or 2 hour fire resistive construction (Section 807 SFHC).

The Field Inspection Manual (FIM) provides guidance to field personnel in enforcing the SFHC. In the FIM, are interpretations of conditions or configurations that have been commonly found over the years in San Francisco buildings. These interpretations provide assistance to the inspector by directly providing him the expertise of the Superintendent of Building Inspection, during the inspection. The interpretations have the force of law, based upon City Attorney opinions. The FIM has been under continuous reexamination and revision since adoption as a working tool in 1961.

(b) The change of use or occupancy provisions include that from non-residential to residential usage. The applicable requirements are contained in the SFBC. The code intent is to require a level of compliance with SFBC provisions based upon the degree to which the overall hazard to the public is increased due to the proposed change. This relative increase in hazard level is specifically provided for in the form of a matrix of original and proposed occupancies (Table No. 5.1, SFBC). With this matrix the code user can readily determine the probable degree of application of new construction standards to the particular building.

(c) Alterations, additions and extensions are handled in the SFBC based upon the principle that all new work meet present day construction standards and arrangements. Under certain circumstances areas outside of the proposed work areas may be subject to new code requirements as well. In Sections 104.B thru F, SFBC, these specfic instances are cited.

(d) There is a seismic requirement in the SFBC that only applies under certain circumstances. This requires that when the structure is to be upgraded seismically, it need only meet the lateral force levels of the SFBC (Section 104.F, SFBC). This was specifically written to permit retention of unreinforced masonry type buildings (not permitted for new buildings) provided that the seismic force levels can be resisted by structural elements such as rigid steel frames, x-bracing or shear walls. This provides a mechanism for retaining and reusing older buildings while protecting public safety.

While the San Francisco approach appears complex and does involve development of specific code philosophies and auxiliary documents, it has addressed the several problems of existing buildings, their up-grading, change of use and retention without requiring the sacrifice of public safety. It has recognized that existing buildings are a considerable asset. Most importantly, the San Francisco approach clearly separates the rehabilitation of an existing residential building from the requirements that may apply for a change in use or occupancy or those invoked by alteration, addition or extension.

(3) *Denver, Colorado.* Unlike Washington and San Francisco, the Denver building code includes both the 25–50% Rule and the general change of occupancy regulation. However, in apparent recognition of the inadequacy of these regulations to support Denver's rehabilitation needs, the City of Denver has added a special chapter, entitled "Rehabilitation of Older Buildings" to its building code (Chapter 31). This chapter achieves several results:

(a) It exempts buildings of specific occupancies erected before 1950 from code compliance under the 25–50% Rule and the change of occupancy regulation.

(b) It declares that, as a matter of policy, rehabilitation of older buildings is a public necessity.

(c) It establishes an administrative mechanism for developing guidelines to be used by the building official in accepting deviations from code requirements in cases where the rehabilitator requests such deviations.

Thus, Denver's regulatory innovation is to explicitly permit deviations from strict code compliance in the case of rehabilitation. It is unclear whether Denver's guidelines imply reduced levels of performance for rehabilitation when compared to new construction requirements, or whether they merely encourage the acceptance of alternative solutions of equivalent performance. Denver's approach is too recent to provide a response to this question.

The City of Denver reports that Chapter 31 is being utilized for the rehabilitation of Denver landmarks, designated historic places, and recently, for other buildings built before 1950. In all cases, it is reported that approvals consider public safety as paramount.

Chapter 31 is published in Appendix 4.

(4) *State of Massachusetts.* Until June, 1979, the State building code in

Massachusetts included the 25–50% Rule and the general change of occupancy regulation (the BOCA code version). On that date the State enacted Article 22, representing a regulatory innovation replacing the 25–50% Rule and the change of occupancy regulation.

In general, Article 22, contains the following:

(a) Definition of hazardous conditions, related to structural performance, number of exits and capacity of exits. These must be eliminated in all existing buildings.

(b) Classification of all occupancies into one of eight hazard classifications, in increasing order of hazard.

(c) Establishment of three levels of required performance for rehabilitated buildings (above the level of hazard elimination noted in (a) above). These levels are a function of the relative change in hazard classification involved in the rehabilitation, and range from a requirement of not reducing the level of performance of the existing building to full compliance with the requirements for new construction.

(d) Explicit encouragement of acceptance of equivalent alternative solutions whenever compliance with new construction requirements is specified.

In summary, the Massachusetts approach is based on the philosophy that the existing building's actual level of performance establishes the level to be complied with in rehabilitation, except for the elimination of a few specified hazards, and except when changing occupancy to one of substantially greater hazard. In other words, the Massachusetts approach to rehabilitation requires compliance with many different potential levels of performance (potentially the number of levels is the number of existing buildings).

There is not yet enough experience to judge the efficacy of this approach, and speicifically the efficacy of basing levels of compliance on a single number hazard index of occupancies.

Massachusetts Article 22 is published in Appendix 5.

D.2 Partial Approaches

Partial approaches to regulatory innovation related to rehabilitation of existing buildings are those which address a specific problem, be it a single hazard (e.g., sesimic loading), a single building component (e.g., electrical system), a single class of buildings (e.g., residential), or any other problem for rehabilitation.

Four examples of partial approaches to regulatory innovation are discussed below and in the appendices.

(1) *State of California.* The State of California has a statewide mandatory code applicable to residential occupancies. The State Housing Law requires that local jurisdictions adopt regulations which are "substantially the same" as those contained in the Uniform Building Code. Some variance is allowed, based on local conditions.

In 1974, the State Housing Law did away with the 25–50% Rule (which at that time was still included in the Uniform Building Code). It did not address the change of occupancy regulation (which would apply to changing use within the residential occupancies, such as apartment house to hotel, or single family dwelling to apartment house, and to change of other occupancies, not governed by the State Housing Law, into housing). The 1974 Law did so by means of several inter-related regulations (see Appendix 6):

- Explicity defining "substandard building" as defined in the Uniform Housing Code (Chapter 10), but excluding (within limits) room and space dimensions from that definition (Chapter 10, Sec. 1001 (b) 9., Uniform Housing code, 1979 Edition), and somewhat liberalizing the definition of hazardous wiring, plumbing and mechanical equipment (ibid, Sec. 1001 (e), (f), (g)). The latter is achieved by stating that if wiring, plumbing and mechancial equipment has been maintained in good and safe condition and is working properly, "it shall be deemed to have conformed to applicable law in effect at time of installation".
- Adoption of specific regulations related to structural fire safety and fire resistant exists (California Administrative Code, Title 25, Chapter 1, Subchapter 1), which are based on an earlier version of Uniform Building Code, Appendix Chapter 12, Existing Buildings, with provision for several exceptions which may be more lenient.
- Specifically stating that state or local regulations governing alteration and repair of existing buildings and moving of apartment houses and dwellings shall permit replacement, retention and extension of original materials and methods, so long as the building does not become a substandard building as defined by the Law.

The State Housing Law also establishes several other detailed requirements related to specific building elements.

The State of California has also enacted a "State Historical Building Code" (Section 18950), the intent of which is ". . . to provide a means to preserve the historical value of designated buildings and concurrently to provide reasonable safety from fire, seismic forces or other hazards to occupants." (Note omission of the usual phrase "and general public".)

The Department of Housing and Community Development of the State of California is currently preparing two documents entitled "Residential Rehabilitation Guidelines" and "A User's Residential Rehabilitation Guide", which amplify and explain the relevant parts of the State Housing Law and related laws and regulations, and provide guidance in defining electrical, mechanical and plumbing hazards.

(2) *City of Los Angeles Rule of General Application on Structural Changes Required by Change of Occupancy.* This regulatory innovation deals only with seismic loads, and illustrates the conscious reduction in requirements applicable to rehabilitation involving a change in occupancy.

The City of Los Angeles has developed a "Rule of General Application" (RGA) to determine when buildings undergoing a change of occupancy or having an increase in the occupant load must be made to conform to current structural requirements. A copy of the rule is included in Appendix 7. A portion of the rule reads as follows:

"In buildings constructed on or after October 6, 1933, a change in occupancy may be made to establish any occupancy classification provided the building is not substantially altered."

The October 6, 1933 date was selected since all buildings constructed in the City of Los Angeles subsequent to October 6, 1933 were required to be designed for earthquake forces. This provision is based upon buildings located in areas subject to seismic forces of the magnitude anticipated in Seismic Zone 4. It is recognized that the level of seismic design force would not be as required under the current building code. However, the building should perform in such a manner as to minimize life loss in the event of an earthquake.

This RGA contains a list of occupancies arranged in order from the least hazardous to the most hazardous. An occupancy or use is generally considered more hazardous as the occupant load within the building or the length of time the building is occupied are increased.

Note that an occupancy hazard listing based on structural performance may not be applicable for consideration of fire safety of the occupants.

(3) *State of California Seismic Safety Commission Draft Legislation Related to Seismic Hazards.* In areas subject to earthquakes, it is well known that unreinforced masonry buildings which have not been designed for seismic effects may be subject to severe damage in moderate earthquakes. Based upon this fact, the Seismic Safety Commission of the State of California is developing legislation related to buildings which would be a hazard when subjected to the level of seismic forces which could be encountered in the State of California. A draft of the proposed legislation is contained in Appendix 8.

This example of regulatory innovation is a form of a hazard abatement code, and is intended to eliminate the problem of complying with portions of the new construction code in removing a particular hazard.

In part, the draft states this directly:

"This bill would authorize a city, city and county, or county to establish construction standards for reconstruction of existing buildings determined, as specified, to be a hazard to life in the event of an earthquake, which standards are as specified in the bill and would eliminate the problem of complying with the latest building code governing new construction when rehabilitating older buildings."

(4) *Chapter 10 of the Official Electrical Code of the City of Detroit, Adopted November 9, 1977 ("Minimum Standards for Existing Dwelling Units").* This Chapter (see Appendix 9) was developed by the City of Detroit and has been proposed for the National Electrical Code. It reflects that city's need to rehabilitate large numbers of single family houses.

Chapter 10 covers the re-wiring of existing inadequately wired dwelling type occupancies. It describes the evidence of inadequacy of wiring, and defines minimum illumination and power requirements for each room or space of the dwelling.

Chapter 10 represents a regulatory innovation because the National Electrical Code does not specifically address existing buildings, and its requirements establish levels of performance for new construction. Chapter 10 establishes lower levels of performance which would be safe and acceptable for existing buildings.

PART II—IDENTIFYING EXISTING CONDITIONS IN A COMMUNITY

The purpose of this Part of the Guideline is to provide policymakers or other interested groups in a community with a procedure for examining the existing conditions in their community to determine what problems, if any, are posed by the existing regulatory system in setting standards for building rehabilitation and re-use. The procedure makes reference to the general introduction and background discussions in PART I of the Guideline, and consists of three steps:

- Define existing regulatory system.
- Define pertinent characteristics of building rehabilitation in the community.
- Identify potential problems.

With identification of problems, policymakers can proceed to PART III of the Guideline, in which recommendations for amending the regulatory system designed to solve the respective problems are discussed.

A. Define Existing Regulatory System

Buildings in a community may be regulated by means of a variety of regulations, as discussed in *Introduction and Background.* That discussion concentrated on the model codes, but a particular community may use model codes, modified model codes or codes of its own.

It is necessary to define how buildings are regulated in a particular community. In doing so, it will be useful to make use of the conceptual diagrams of required building performance presented in the *Introduction and Background.*

The definition of the existing regulatory system consists of four parts:

- Define those requirements imposed on all existing buildings, and their enforcement.
- Define new construction requirements and their enforcement.
- Define existing provisions addressing building rehabilitation and reuse.
- Compare criteria levels.

A.1 Define Those Requirements Imposed on All Existing Buildings, and Their Enforcement

(1) Hazard Abatement Code

(a) Determine whether a code for the abatement of dangerous buildings, or a similarly titled document, is in effect as a hazard abatement code in the community. Note that similar provisions may be part of the building code.

(b) If such a code or provisions are in effect, determine whether they include explicit criteria for various enforcement options by the authority having jurisdiction. Such criteria may be found in inspection manuals or similar ancillary documents as well as in the regulations themselves. Specifically, determine whether the code contains a workable definition of "imminent hazard", warranting immediate remedial action to be enforced by the authorities. If the criteria are defined by reference to another code (e.g., building code, electrical code, etc.), the explicit criteria should still be identified.

(c) Exhibit the criteria for "imminent hazard" and for other hazards covered by the hazard abatement code, in the categories of structural safety, fire safety, health and hygiene, and any further breakdown of these categories as appropriate.

(d) Determine how the hazard abatement code is enforced, and by what agency. Specify whether its enforcement is a function of geographical location within the community, and if so, specify how. Specify whether the code is enforced differently in different occupancies or types of buildings.

(e) Determine how the hazard abatement code's enforcement is triggered. Specify if it is triggered uniformly for all buildings or classes of buildings, or whether it is triggered by actions other than the mere presence of the hazard, such as application for a building permit.

(2) Building Maintenance Codes (Property Maintenance/Housing/Health/Fire Prevention)

(a) Determine whether a housing code, property maintenance code, fire prevention code, health code, or any other regulation which may similarly cover the maintenance, operation and use of buildings, are in effect in the community. Some of these provisions may be part of building, mechanical, plumbing or electrical codes. For all such codes in effect, determine whether they include explicit criteria for various enforcement options by the authority having jurisdiction. Such criteria may be found in ancillary inspection manuals, or may be specified by reference to the building, mechanical, plumbing or electrical codes.

(b) Exhibit the criteria for various enforcement actions contained in these codes, in the categories of structural safety, fire safety, health and hygiene, and any further breakdown of these categories as appropriate.

(c) Determine how each of these maintenance codes is enforced, and by what agency. Specify whether each code's enforcement is a function of geographic location within the community (e.g., target neighborhoods for housing code enforcement). Specify whether each code's enforcement is varied as a function of occupancy or building type (e.g., active housing code enforcement in nursing homes, active fire prevention code enforcement in public assembly occupancies, etc.).

(d) Determine how the enforcement of each maintenance code is triggered.

Specify how violations of these codes are brought to the attention of the authorities, and whether the codes' enforcement is triggered uniformly for all buildings, classes of buildings, neighborhooods or similar classifications, or whether it is triggered by actions independent of the normal operation, maintenance and use of existing buildings, such as application for a building permit.

(3) Retroactive Regulations

(a) Identify all retroactive regulations currently applicable to existing buildings in the community.

(b) For each retroactive regulation, identify the unsafe or undesirable conditions which the regulation is intended to correct. Specify whether the regulation applies to all buildings, to specific occupancies or building types, or to any other limited category of buildings.

(c) For each regulation, determine the criteria which must be met for compliance. These criteria may be established by reference to the building code or some other code.

(d) Exhibit the criteria for compliance with each retroactive regulation in the categories of structural safety, fire safety, health and hygiene, as applicable.

(e) Determine how each retroactive regulation is enforced, and by what agency. Specify whether the enforcement is a function of geographic location within the community, or of any categorization of buildings (e.g., by occupancy, type, age, condition, etc.).

(f) Determine how the enforcement of each retroactive regulation is triggered. Specify how deficiencies are brought to the attention of the authorities. Determine whether the enforcement is triggered by actions which are independent of the presence of the specific deficiencies, such as application for a building permit.

A.2 Define New Construction Requirements and Their Enforcement

(a) Identify all existing codes currently applicable to new construction in the community. These may include a building code, mechanical code, plumbing code, electrical code, various specialty codes, life safety codes and special regulations. For each code, determine whether it is locally promulgated, or whether it is a statewide code. If it is the latter, determine whether it is mandatory minimum, maximum or both.

(b) Determine the occupancy and use categories into which buildings are classified by the codes. Determine fire districts, or other locational categories into which buildings are classified by the codes.

(c) For each building classification, determine the criteria which must be met for compliance.

(d) Categorize these criteria into the same, or similar categories to those utilized for displaying the criteria for the codes and regulations applicable to existing buildings as specified in the preceding section. Display the criteria in these categories to the extent and level of detail possible.

(e) Describe how the codes covering new construction are enforced, and by what agencies. Include in this description any cross referencing or interagency coordination employed in the enforcement. If code enforcement is carried out by various levels of government (state, county), it should be fully described. Determine the mechanisms for triggering code enforcement activities, such as application for building permits, mechanical permits, electrical permits, etc.

A.3 Define Provisions Covering Building Rehabilitation

(1) 25–50% Rule

(a) Determine whether the community's building code includes the 25–50% Rule or similar rule covering building repair and alteration. Determine whether a similar rule is included in the mechanical, plumbing and electrical codes.

(b) Determine how the building code addresses additions to existing buildings.

(c) If the 25–50% Rule, or similar rule, is in effect, determine the criteria that are required for compliance when rehabilitation work falls into each of the following three, or similar applicable categories:

- under 25%
- 25–50%
- over 50%

(d) Determine whether reference is made to any other codes (e.g., the code under which the building was originally built) in establishing these criteria.

(e) Display the criteria for compliance in the same categories as those utilized in the preceding section.

(f) If the 25–50% Rule, or similar rule, is in effect, determine how it is enforced. Specify how the value of the numerator (value of repair and alteration work) is determined in terms of work items covered and cost estimates. Specify how the value of the denominator (value of the existing building) is determined.

(g) Determine whether the 25–50% Rule is enforced uniformly for all buildings, or whether its enforcement differentiates between classes of buildings on any basis.

(h) Determine whether the 25–50% Rule discriminates against certain building owners or certain neighborhoods in the community, by resulting in the impostion of different criteria for similar rehabilitation of similar buildings.

(2) Change of Occupancy

(a) Determine the current regulation governing code compliance of existing buildings involved in a change of occupancy. Usually this regulation is part of the building code.

(b) Determine whether the change of occupancy regulation requires full compliance with all code requirements for new construction of the occupancy proposed, or whether only partial compliance is required. If partial compliance is included in the regulation, determine whether it is based on a systematic ordering of occupancies in terms of hazard, or on a similar defined analytical procedure.

(c) If partial compliance is included, determine the criteria which are established for each category of occupancy change, and display the criteria in the same categories as those utilized in the preceding section.

(d) Determine how the change of occupancy regulations are enforced, and whether they are enforced uniformly throughout the community.

(3) Other Rehabilitation Provisions

(a) Identify all other provisions which may affect building rehabilitation in the community. These may include landmark and historic district ordinance provisions, historic preservation waivers, regulation of moved buildings, general building rehabilitation provisions, etc. Some of these may be included in the building code, in ancillary inspection manuals or similar documents.

(b) Determine what criteria are specified for compliance with any such special provision, and display them in the same categories as those utilized in the preceding section.

(c) Determine how these special provisions are enforced, including use of advisory boards, review panels, appeals boards, etc.

A.4 Compare Criteria Levels

Compare the displays of the various sets of criteria included in all elements of the existing building regulatory system in the community which were defined and displayed under A.1–A.3 of this Part. This comparison may take the form (graphically or conceptually) of the conceptual diagram included in Part I of

this Guideline. In such an approach, the criteria for new construction are likely to define an upper limit of performance. The requirements imposed on existing buildings are likely to define a lower limit of performance. The existing regulations governing building rehabilitation will define where different categories of rehabilitation are required to fall between these two limits.

This comparison and display of criteria levels will identify for policymakers the extent of upgrading required for rehabilitated buildings by the existing regulatory system, and will enable them to determine whether this upgrading is consistent with local rehabilitation policies.

B. Define Pertinent Characteristics of Building Rehabilitation in the Community

Building rehabilitation in a community is a function of many factors, such as:

- physical characteristics of the community
- age and condition of the building stock
- economic conditions of development
- socio-economic conditions in the community
- regulatory system and its history
- public policy at the federal, state and local levels of government.

It is necessary to define the following pertinent aspects of building rehabilitation, and their relationship to some of these factors:

- Define occupancies involved or potentially involved in rehabilitation.
- Define building ages and types involved or potentially involved in rehabilitation.
- Determine extent of illegal rehabilitation.
- Define existing rehabilitation policies.

B.1 Define Occupancies Involved or Potentially Involved in Rehabilitation

Determine whether building rehabilitation in the community is principally a matter of upgrading or re-use of existing occupancies (e.g., residential rehabilitation, commercial rehabilitation, etc.), or whether it is a matter of changing occupancies (e.g., commercial to residential, residential to commercial, residential to assembly, etc.). This can be determined both by observing actual current rehabilitation projects, as well as by identifying potential candidates for rehabilitation (which due to existing problems or constraints may not be currently undergoing rehabilitation).

The nature of occupancy changes involved in rehabilitation is often related to the changing nature of neighborhoods and of the community as a whole, and is therefore subject to the economic conditions of development, socio-economic and physical characteristics of the community.

It is important to define the occupancies involved, or potentially involved in rehabilitation, because the building regulatory system is likely to treat rehabilitation involving occupancy change very differently from that in which no change is involved. In general, the former is likely to entail the enforcement of higher levels of performance in the rehabilitated building. For this reason it is also necessary to determine the extent to which the occupancy classifications contained in the community's building code (see A.2(b) of this Part I) correspond to, or fit with, the actual uses of buildings being rehabilitated. If this correspondence, or fit, is not clear, then the regulatory system will involve ambiguities in dealing with change of occupancy rehabilitation.

B.2 Define Building Age and Types Involved or Potentially Involved in Rehabilitation

Determine the age and principal characteristics (structural, architectural, mechanical) of buildings involved, or potentially involved in rehabilitation work in the community. This can be determined by both observing current projects as well as identifying potential candidates for rehabilitation.

While the age and principal characteristics of buildings are mainly a part of the general physical characteristics of the community, it must also be analyzed in relation to the history of the building regulatory system in the community. Such an analysis will determine the extent of the disparity between the characteristics and performance of the existing building stock and the current code requirements for new construction. For example, a community where most of the buildings are 25 years od, and where there have been very few code changes during that period, will have very different problems of regulation of rehabilitation than a community with buildings over 50 years old and with a history of numerous code changes. Washington, D.C. and San Francisco fall into the latter category, which may explain the specific nature of their regulatory approach to rehabilitation (as discussed in Part 1 of this Guideline).

B.3 Determine Extent of Illegal Rehabilitation

Illegal rehabilitation is the practice of carrying out repairs and alterations in buildings without the permits required for such work by a community's regulatory system. It is necessary to determine the extent and nature of such rehabilitation occurring in the community, and to identify the classes of building in which it is occurring, because this characteristic may indicate the effectiveness of the regulatory system in dealing with rehabilitation. The extent and nature of this phenomenon may also help in identifying potential problems of safety, health and hygiene which should be addressed by the regulatory system for rehabilitation.

B.4 Define Existing Rehabilitation Policy

Identify all the current policies related to building and neighborhood rehabilitation which are in effect in the community. These policies may be federal (expressed by the community's acceptance of federal assistance), state, local or neighborhood generated.

Specify the building classes or types which are addressed by the rehabilitation policy.

Attempt to determine the relative real costs which these rehabilitation policies intend for the community to bear. For example, how much, if any, relative safety, convenience and other features should the community be willing to give up in order to achieve the goals of the rehabilitation policies.

C. Identify Potential Problems

If the following conditions are found in the community, it could indicate problems in need of solution:

(1) *Conflict between the goals of rehabilitation and the goals of building regulation.* The health and safety goals of the building regulatory system are usually not made explicit in a community. However, the existence of the conflict between rehabilitation goals and regulation goals may be determined by the community if it finds that current building regulations impose unacceptable cost on rehabilitation and prevent much rehabilitation from taking place. The current regulations may impose these costs either by forcing the upgrading of rehabilitated buildings to levels of performance which are too high for the community, or by accepting only design solutions prescribed for new construction.

The community may also determine that such a conflict exists between rehabilitation and regulation goals when the enforcement of the regulations on existing buildings (hazard abatement codes, property maintenance codes and retroactive regulations) is triggered only by application for building permits. In this case the enforcement system is

discriminating against all rehabilitation activities of the community, by enforcing regulations that should apply to all existing buildings.

(2) *Discrimination of current rehabilitation regulations against a class of buildings or owners.* This condition may occur in a community which applies the 25–50% Rule to rehabilitation, as discussed above.

(3) *Violation of existing regulations.* The existence of extensive illegal rehabilitation work in the community, as discussed above, is evidence of this condition.

The above conditions may indicate the existence of one or more of the following four problems, listed in increasing order of the required modification to the regulatory system. Each problem is defined in PART III of this Guideline, where recommendations are made for solutions.

1. No modification in current regulatory system (25–50% rule and change of occupancy regulation) is needed.
2. Flexible application of the 25–50% rule is needed.
3. Existing regulatory system, in its relation to building rehabilitation, is in need of modification.
4. A definition of imminent hazards is needed in the regulatory system.

PART III—RECOMMENDATIONS FOR AMENDING OR MODIFYING THE REGULATORY SYSTEM TO ENCOURAGE REHABILITATION

A discussion of rehabilitation problems is contained in an article by William J. Tangye, P. E., entitled *"Rehabilitation of Existing Buildings An Achievable Goal"*, printed in Southern Building, February/March 1980. The article includes several recommendations, including proposed additions or amendments to the Standard Building Code, and is reprinted with the permission of the Southern Building Code Congress International, Inc., as Appendix 11 of this guideline.

The following recommendations are established for each of the four problems defined in the preceding part of this guideline. In general, a community will find that it is faced with one or more of these problems. All communities, however, should refer to the accompany *Statutory Guideline for Building Rehabilitation, Guideline for Managing Official Liability Associated with Building Rehabilitation,* and the *Guideline for the Approval of Building Rehabilitation* for recommendations which are consistent with all four problems.

Also, all communities should consider enacting historic preservation waiver clauses, if they have not already done so.

A community located in a state which has statewide preemptive codes may be constrained in carrying out some or all of the following recommendations. It should determine the extent of such constraints before attempting to amend or modify its regulatory system.

1. No modification in current regulatory system (25–50% rule and change of occupancy regulation) is needed.

Problem. The community determines that its current building code provisions applicable to rehabilitation, including the triggering of full code compliance by the 25–50% Rule and by the change of occupancy regulation, do not represent conflicts with rehabilitation goals, do not intentionally unduly constrain building rehabilitation and do not discriminate against classes of buildings or owners. Such a community accepts the impposition of new construction standards on much of its rehabilitation. However, the community determines that rehabilitation is unintentionally constrained by the prescriptive nature of many building code requirements.

Recommendations. The community should do the following:

(a) Explicitly justify, as a matter of public policy, each code requirement which is applied by current regulations to rehabilitated buildings, and which is in excess of the current requirements applicable to existing (unrehabilitated) buildings (e.g., hazard abatement code, property maintenance code and retroactive regulations).

(b) Amend the building code, electrical code, plumbing code, etc. to explicitly mention the acceptability of alternate materials, methods of construction and designs when dealing with buildings under the 25–50% Rule and with buildings undergoing a change of use or occupancy.

(c) Implement the following technical guidelines:

- *Egress Guideline for Residential Rehabilitation*
- *Electrical Guideline for Residential Rehabilitation*
- *Plumbing DWV Guideline for Residential Rehabilitation*

In general, each of these guidelines suggests alternative solutions recommended for building rehabilitation, which provide approximately equivalent performance as specified by current codes for new construction.

(d) Implement technical guidelines similar to those of (c) above, which may be developed and published from time to time, or develop and implement similar guidelines of its own.

2. Flexible application of the 25–50% rule is needed.

Problem. The community's current building regulations include the 25–50% Rule. The majority of building rehabilitation in the community does not involve a change in use or in occupancy. The community's goals are to encourage such rehabilitation, and the community is will to accept a level of performance for its rehabilitated buildings which is lower than that required for new construction. However, the 25–50% Rule as currently enforced requires full code compliance in more cases than the community finds appropriate and/or discriminates against classes of buildings or owners in the community.

Recommendations. The Community should consider the following:

(a) *Defining Cost and Value.* In any jurisdiction which has the 25–50% Rule and desires to interpret it so as to promote rehabilitation as much as possible, the objective is to obtain the lowest possible ratio of cost of rehabilitation (numerator) to the value of the building (denomination). The definition of cost, therefore, should be as low as possible. Based upon case studies the following methods of defining cost are either in use or suggested by building officials. Except where noted, these interpretations may be made by the building official without changing regulations.

(i) *Defining Cost of Rehabilitation (the numerator).*

Objective: Obtain Lowest Possible Value.

- Exclude all non-permit items such as painting and decorating, kitchen cabinets, landscaping, architect's fee and the like.
- Exclude all items which require a separate permit and which are normally covered by a separate code not governed by the 25–50% Rule, such as plumbing, electrical and elevator.

(ii) *Defining Value of the Building (the denominator).*

Objective: Obtain Highest Possible Value.

- Define value as current replacement cost before rehabilitation, and update at least annually.
- Define value as current replacement cost *after* rehabilitation. (This may not be feasible under the Standard Building Code since it requires the "then" physical value, presumably before rehabilitation. Also, the Basic Building Code implies replacement value before rehabilitation although this is not specifically stated.)
- Assessed value is reportedly used in some jurisdictions, but in general

assessed value lags behind true replacement value. In addition, assessing practices often assess various occupancies using different methods which could lead to discrimination.

(b) *Varying the Percentages.* Consider increasing the percentages (e.g., 33–66% instead of 25–50%). This will tend to allow more rehabilitation before encountering new construction code requirements. To implement this change, a code amendment is required.

(c) *Reducing the Time Span.* The model codes and most local codes require that for purposes of the 25–50% Rule cost be defined as work done within one year. Reducing the time span to six months, for example, would tend to allow phased upgrading of buildings. This change, also, requires a code amendment.

(d) Consider the use, or possible modification (to reflect acceptable lower levels of performance), of the technical Guidelines as suggested for the preceding problem.

3. Existing regulatory system, in its relation to building rehabilitation, is in need of modification.

Problem. The community determines that its current building regulations conflict with its rehabilitation goals by requiring upgrading of many or most of its rehabilitated buildings to the performance levels specified for new construction or even to some lower level, leading to unacceptably high costs of rehabilitation which unduly constrain building rehabilitation. Also, the community may determine that the regulatory system discriminates by enforcing existing building regulations in cases of rehabilitation only.

Recommendations. The community should do one of the following:

(a) Consider applying or adapting a current regulatory innovation; or

(b) Develop its own local rehabilitation code, provisions or guidelines.

(a) *Consider applying or adapting a current regulatory innovation.* Part I and the Appendix of this guideline contain discussions of various existing comprehensive or partial regulatory innovations. These include:

- Washington, D.C. (Appendix 2)
- San Francisco, California (Appendix 3)
- Denver, Colorado (Appendix 4)
- State of Massachusetts (Appendix 5)
- State of California (Appendix 6)
- City of Los Angeles Rule of General Application on Structural Changes Required by Change of Occupancy (Appendix 7)
- State of California Draft Legislation Related to Seismic Hazards (Appendix 8)
- Chapter 10, Official Electrical Code of the City of Detroit (Appendix 9)

The community faced with this problem may consider adopting or modifying one or more of these regulatory innovations. Such a community should do the following:

(i) Analyze each innovation in detail, from the materials appended to this guideline, and from additional materials obtained locally as required. This analysis should pay particular attention to the specific community characteristics (physical, social, economic, political, etc.) which led to the development of each regulation. Since each of the regulation examples was developed to respond to local community conditions and needs, a given community considering adopting such a developed regulation must be aware of the similarities and dissimilarities of its own community characteristics in relation to those of the model being analyzed. A level of performance acceptable in one community may not be acceptable in another.

Note that of the complete "solutions", Washington, D.C. and San Francisco use specific, and often prescriptive, provisions applicable to rehabilitation. These may have limited transferability to any but very similar cities. Denver provides a mechanism for dealing with every case individually, rather than establishing comprehensive provisions. Massachusetts uses an approach in which every building defines the level of performance to which it must be rehabilitated.

(ii) Based on the analysis, adopt and/or modify one of the model regulatory innovations.

(iii) Amend current codes appropriately, including deletion of the 25–50% Rule and/or the change of occupancy provisions. It must be realized that such deletions require the substitution of specific provisions. It should also be noted that by deleting the 25–50% Rule, a community may inadvertently have a deleterious effect on rehabilitation below 25%, which currently enjoys the continuation of non-conforming rights.

(iv) Consider the use, or possible modification (to reflect acceptable lower levels of performance), of the technical guidelines as suggested in the preceding problem.

(b) *Develop local rehabilitation code or guidelines.* If the community determines that none of the regulatory innovations are applicable, it should develop its own rehabilitation code, regulation or guidelines. It may proceed as follows:

(i) Determine the levels of performance required for all existing buildings by the current hazard abatement code, property maintenance code and retroactive regulations. As a minimum, all rehabilitated buildings must meet these levels. Note that in the absence of a current definition of "imminent hazard", the recommendations for Problem 4, below, should be followed.

(ii) If the community determines that higher levels of performance than those determined in (i) above are to be required for rehabilitated buildings (involving no occupancy change and/or involving change of occupancy), each such requirement should be individually justified, as a matter of public policy. The justification should cover structural safety, fire safety, health and hygiene.

(iii) Amend current codes appropriately, including deletion of the 25–50% Rule and/or the change of occupancy provisions. It must be realized that such deletions require the substitution of specific provisions. It should also be noted that by deleting the 25–50% Rule, a community may inadvertently have a deleterious effect on rehabilitation below 25%, which currently enjoys the continuation of non-conforming rights.

(iv) Consider the use, or possible modification (to reflect acceptable lower levels of performance), of the technical guidelines as suggested in the preceding problem.

A format and methodology for developing a local rehabilitation code, based on comparative analysis of rehabilitation needs with the code requirements for new construction, is presented in Appendix 10 of this guideline.

4. A definition of imminent hazards is needed in the regulatory system.

Problem. The community may have a need to define "imminent hazard". For a community facing any of the preceding three problems, the problem may be its desire but inability to establish compliance priorities for any level of performance.

For a community facing problem categories 2 or 3 above (i.e., considering acceptance of lower levels of performance for rehabilitated buildings), the problem may be the inability to establish the absolute lowest acceptable level of performance by requiring only the elimination of "imminent hazards" as a requirement attending rehabilitation.

Recommendations. To assist the community in assessing an "imminent

hazard", the following attributes and criteria should be considered:

(a) *Structural Safety.* A building presents an imminent hazard:

(1) Whenever the stress in any materials, member or portion thereof, due to all dead and live loads, is more than one and one-half times the working stress or stresses allowed in the code for new buildings of similar structure, purpose or location.

(2) Whenever any portion thereof has been damaged by fire, earthquake, wind, flood or by any other cause to such an extent that the structural strength or stability thereof is materially less than it was before such catastrophe and is less than the minimum requirements of the code for new buildings of a similar structure, purpose or location.

(3) Whenever any portion or member or appurtenance thereof is likely to fail, or to become detached or dislodged, or to collapse and thereby injure persons or damage property.

(4) Whenever any portion of a building, or any member, appurtenance, or ornamentation on the exterior thereof is not of sufficient strength or stability, or is not so anchored, attached or fastened in place as to be capable of resisting a wind pressure of one-half of that specified in the code for new buildings of similar structure, purpose or location without exceeding the working stresses permitted in the code for such buildings.

(5) Whenever any portion thereof has racked, warped, buckled or settled to such an extent that walls or other structural portions have materially less resistance to winds or earthquakes than is required in the case of similar new construction.

(6) Whenever the building or structure or any portion thereof because of: a) dilapidation, deterioration or decay; b) faulty construction; c) the removal, movement or instability of any portion of the ground necessary for the purpose of supporting such buildings; d) the deterioration, decay or inadequacy of its foundation; or e) any other cause, is likely to partially or completely collapse.

(7) Whenever the exterior walls or other vertical structural members list, lean or buckle to such an extent that a plumb line passing through the center of gravity does not fall inside the middle one-third of the base.

(b) *Number of Exits.* A building presents an imminent hazard whenever less than two approved independent exitways serve every story (except as modified for single exitways by current building codes or by the accompanying *Egress Guideline for Residential Rehabilitation*).

(c) *Capacity of Exits.* A building presents an imminent hazard whenever any required door, aisle, passageway, stairway or other required means of egress is insufficient to comply with the current code section on exit capacity or is so arranged as to preclude safe and adequate means of egress (see *Egress Guideline for Residential Rehabilitation*).

(d) *Other.* A building presents an imminent hazard whenever conditions exist which in the code official's judgment would be cause for an otherwise fully code-complying building to be evacuated or padlocked, or for the site or other adjacent areas to be evacuated, barricaded or otherwise protected.

Appendix 3—San Francisco, California

San Francisco, Calif.

The following concepts are involved in San Francisco's approach to regulating rehabilitation:

(a) *Residential Buildings (SFHC).*

1. Limiting areas of concern. (Section 105 and 309 SPHC)

2. Providing less strict construction standards, than for new construction, for areas of concern.

3. Providing a legal means for developing and implementing regulations "supplemental to this code and not in conflict therewith." this enables the creation of FIM. (Section 104 (f) SFHC and 204.2 SFBC)

4. Developing a manual (FIM) based upon commonly found conditions so as to provide both equity and uniform enforcement of alternatives and interpretations.

(b) *Change in Use or Occupancy (SFBC).*

The SFBC criteria primarily relate to the degree to which the proposed change may generate additional public hazard (Sections 104.E–3, 502.1(e), SFBC). The SFBC requires changes involving large public assemblies, schools and hospitals to virtually fully meet the present standards. It does not require this for most changes involving commercial or residential usage. These more common changes, as well as all others, are subject to one of three levels of possible building code application, indicated in Table No. 5.1, SFBC. This Table was developed based upon an evaluation of the potential increase or decrease in public safety from fire, panic and other hazards that may result from the proposed change.

These three levels are: (See Table No. 5.1 SFBC footnotes)

Level 'P'—This level requires only that the exists, ventilation, sanitation and fire fighting elements meet the SFBC. Seismic upgrading, per Section 104.F SFBC only applies when the occupant or floor load increases (e.g., a warehouse change to office building, or a garage converted to a heavy manufacturing plant), provided however that no seismic upgrading is required per Section 104.E–3 SFBC unless the change involves more than 30% of the building area. This latter provision was added so as to avoid minor changes causing extensive or costly work on the building.

Level 'PS'—This level requires that specific evaluation of the proposed change be made by the Bureaus of Building Inspection and Fire Prevention so as to determine what other SFBC provisions (other than those required for Level 'P') may be required to adequately protect the public.

"Blank" Space—This level requires that the change must fully meet the present SFBC requirements since the hazard level increases warrants such compliance for public safety.

(c) *Alterations, Additions and Extensions (SFBC)*

1. When substantially the entire interior of the building undergoes change ("gut job"), it is anticipated that there will be sufficient funds involved to warrant invoking seismic upgrading requirements for public safety. (Section 104.C–4, SFBC).

2. When virtually all walls are undergoing change (75% or more) all remaining walls on the floor involved have to be also upgraded. This is also based on the substantial financial involvement. (Section 104.C–3, SFBC).

3. When more than 30% of the building is involved in structural changes, the seismic provisions of Section 104.F, SFBC are invoked. (Section 104.B–3, SFBC).

Following are the pertinent sections of the San Francisco Building Code (SFBC) and Housing Code (SFHC).

San Francisco Building Code

Sec. 104A. Application to Existing Buildings, General. Buildings or structures to which additions, alterations, or repairs are made, or in which the occupancy of all or a portion of the building is to change from that for which a permit has been issued, shall comply with all requirements for new buildings or structures except as specifically provided in Sections 104.A through 104.H and as required in the Housing Code.

→The term "portion of the building" shall mean the floor or floors that are affected by the change in use.

Notarized certifications describing the extent of all previous substantial alteration work and/or previous changes of occupancy shall be

submitted by the owner and the designer of a proposed alteration or change of occupancy when required by the Superintendent.←

For construction in Fire Zones, see Article 16.

Sec. 104.B Alteration Work, Structural. In any alteration, repair, installations, or change or reconstruction of any building, the new work and any part of the building which becomes an integral part of, or is directly affected by such work, shall meet the structural requirements of this Code, →for vertical loads.

For the purpose of this section, a floor of a building shall include all the structure supporting a level of the building between the underside of said structure and the underside of the structure supporting the level of the building next above.

The extent of an existing building that is considered as being directly affected by the new work, with regard to structural considerations, shall be determined using the following criteria:

1. When structural alteration work is to be done on a floor or floors of a building or structure, the work on the floor or floors involved shall comply with the structural requirements of this Code. The structure above and below the floor or floors involved shall be improved, if and as required, so that they are not adversely affected by the structural work proposed.

2. When the floor loading is increased on the floor or floors of a building or structure, the floor or floors involved shall meet the structural requirements of this code and all structure below the floor or floors with increased loading shall not be adversely affected.

3. When more than 30%, cumulative since the building was built, of the above grade area of the building or structure are involved in substantial structural alteration work, the entire building or structure shall comply with the structural requirements of Section 104.F.←

Sec. 104.C. Alteration Work, Architectural. In any alteration, repair, installation, or change in or reconstruction of any building, the new work and any part of the building which becomes an integral part of, or is directly affected by the new work, shall meet the requirements of the Code.

The extent of an existing building that is considered as being directly affected by the new architectural alteration work shall be determined, using the following criteria in addition to the provisions of Section 502.1:

1. All new work added to the building that did not previously exist in the building.

2. All portions of the building that are removed and replaced by new construction.

3. When 75% of the existing interior walls or partitions, as measured by the lineal footage of such interior wall and partition, are removed on a floor or when new interior walls or partitions are added which exceed 75% of the total lineal footage of the combined existing and new interior walls and partitions that would then be in place on a floor, all interior walls and partitions on the floor involved shall comply with this Code.

→4. Whenever alteration work involves extensive changes to elements such as walls, partitions, ceilings, etc. in substantially all portions of such structure, the structure as a whole shall comply with Section 104.F.←

→**Sec. 104.D. Additions to Buildings. 1. Vertical Extensions.** Buildings may be extended vertically subject to the following requirements:

a. Building shall be used for the same occupancy classification as originally built or for less hazardous occupancy classification as determined from Table No. 5–1. The occupancy of the vertical extension shall comply with the requirements of this Code.

b. Way of departure facilities for the entire structure shall be of sufficient width for the total occupancy load of the building, including the vertical extension, and shall be computed on the basis of occupant loads as assigned in the code in effect at time of the original building erection.

c. All new construction work involved in the vertical extension shall conform to the requirements of this code.

d. The structure as a whole shall comply with Section 104.F.

e. All stairways in the building serving 3 or more stories shall be enclosed.

f. For height and area limitations see Article 5.

g. The original building and the vertical extension shall comply with the applicable provisions of Article 38.

2. **Horizontal Extensions**

a. Building may be used for higher life safety exposure, provided the structure as a whole meets the requirements in this code for such occupancy.

b. See Subsection 1(b).

c. See subsection 1(c).

d. When the cumulative area of additions above grade exceeds 30% of the above grade area of the original building and the additions are structurally interconnected to or inadequately separated from the original building, the entire structure shall comply with Section 104.F.

e. See Subsecton 1 (e).

f. See Subsection 1 (f).

g. See Subsection 1 (g).←

→**Sec. 104.E. Change of Occupancy.** The exit requirements shall pertain solely to the corridors and vertical enclosures of the floor or floors affected by the change in use, which requirements shall also include the vertical enclosure for the floor next above the affected floor or floors. This exit requirement shall not include the corridors and vertical enclosures for the floors below the affected floor or floors or the corridors above the effected floor or floors, except as otherwise stated herein.

1. Where a change in occupancy classification is proposed, the requirements of Table No. 5–1 shall apply.

2. When the change in use involves an increase in the occupant load of the floor or floors affected or when the change involves Occupancies A, B, C, D and E, the exit requirements shall include the vertical enclosures in accordance with Article 33 from the floor or floors in question to the ground at a street or public space. The exit requirements shall include the corridors of the floor or floors affected by the change in use and shall not include the corridors for the floors above or below the affected floor or floors.

3. Whenever the cumulative areas involved in change of occupancy to a greater life safety exposure from that for which the building was originally designed exceed 30% of the original above grade area of the building, the entire building shall be made to comply with Section 104.F.

Exceptions. When the occupancy change is to a Group A, B Div. 1 or B Div. 2 classification and Group B Div. 3 classification with an occupant load over 300, the entire building shall be made to comply with Section 104.F.

2. When the occupancy change is to a Group C classification the entire building shall be made to comply with the requirements of footnote 1 of Table No. 5.1 as well as the Sec. 104.F.←

BILLING CODE 4210-01-M

TABLE NO. 5.1

OCCUPANCY CHANGES PERMISSIBLE WITHOUT CONFORMING TO ALL PROVISIONS OF PRESENT CODE

From \ To	OCCUPANCY GROUP																		
	A	B-1	B-2	B-3	C[1]	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1[1]	F-2	F-3	G	H	I	J-1
A	P	P	P	P	P		PS	PS					PS	P	PS	PS		PS	P
B-1	PS	P	PS	P	P		PS	PS					PS	P	PS	PS		PS	P
B-2	PS	PS	P	P	P		PS	PS					PS	P		PS		PS	P
B-3				P	P		PS	PS					PS	P		PS		PS	P
C				PS	P	PS	PS	PS					PS	P		PS	PS	PS	P
D-1				PS		P							PS	P		PS	PS	PS	P
D-2				PS	P		P	P					PS	P		PS	PS	PS	P
D-3				PS	P			P					PS	P		PS	PS	P	P
E-1									P	P	P					PS		PS	P
E-2									PS	P	P	P	PS			PS		PS	P
E-3									P	PS	P		PS			PS		PS	P
E-4												P	PS			PS		PS	P
F-1													P	P		PS		PS	P
F-2					PS			PS					PS	P		PS	PS	PS	P
F-3													PS	PS	P	PS			P
G												PS			PS	P			P
H				PS	PS	PS	PS	PS						P		PS	P	P	P
I					PS									PS			PS	P	P
J-1																			P

LEGEND for Table No. 5.1

P — Occupancy change permitted subject to the requirements of Sections 902.1 and 1706.A, except for ducts, Tables No. 5-C, 5-D, and 5-E, and Article 38.

PS — Occupancy change permitted subject to requirements as set forth by the Superintendent, and the Bureau of Fire Prevention and Public Safety for those occupancies under their jurisdiction.

Where square is blank, change in occupancy requires substantial conformance with all present code provisions.

[1] Shall require conformance with Article 23 for seismic provisions. Same as used by State OAC. [1] Not including service stations and gasoline filling stations.

BILLING CODE 4210-01-C

TABLE NO. 5

OCCUPANCY CLASSIFICATIONS

Group or Class	Division	Description of Occupancy	Article Reference
A		Any assembly building with a stage and an occupant load of 1000 or more	6
B	1	Any assembly building with a stage and an occupant load of less than 1000	7
	2	Any assembly building without a stage and with occupant load of 1000 or more	
	3	Any assembly building without a stage and with occupant load of less than 1000	
	4	Stadiums, reviewing stands and amusement park structures not included in Group A nor Group B, Division 1, 2, and 3 Occupancies	
C		Any building used for school purposes involving assemblage for instruction, education or recreation	8
D	1	Jails, prisons, reformatories, houses of correction and buildings where personal liberties of inmates are similarly restrained, mental hospitals	9
	2	Nurseries for children under six, kindergartens, orphanages, hospitals, sanitoriums, nursing homes and similar buildings (each accommodating more than 6 persons) with non-ambulatory patients	
	3	Nursing homes for ambulatory patients, homes for children of kindergarten age or over (each accommodating more than 6 persons not including employees)	
E	1	Manufacture, storage and handling of hazardous and highly flammable or explosive gases, liquids and materials other than flammable liquids	10
	2	Storage and handling of flammable liquids	
	3	Shops and factories where loose combustible fibers or dust is manufactured, processed, or generated. Warehouses where loose combustible material is stored	
	4	Public repair garages. Heliports. Storage and parking garage for trucks and buses	
F	1	Gasoline filling and service stations, factories and workshops using material not highly flammable or combustible, large garment shops. Furniture warehouses and similar not more hazardous warehouses	11
	2	Wholesale and retail stores, office buildings, printing plants, municipal police and fire stations, public assembly with an occupant load of less than 50, small garment shops, paint stores without bulk handling, day care of children	
	3	Public Parking Structures and storage garages Type A—Drive-in Type B—Mechanical parking Type C— →Drive-in or←Mechanical parking—Type 4 construction	
G		Ice plants, power plants, pumping plants, cold storage and creameries. Factories and workshops using incombustible and non-explosive materials. Storage and salesrooms for incombustible and non-explosive materials	12
H		Hotel, motels, and apartment houses; dormitories for more than six persons in aggregate; convents, monasteries and rectories each containing six or more sleeping rooms	13
I		One and two family dwellings and lodging houses	14
J	1	Private garages. Sheds and minor buildings used as accessories, fences over six feet high, tanks and towers	15
	2	Stables	

→**Sec. 104.F. Lateral Force Design Requirements.** The provisions of Sec. 2308 and Sec. 2314.D through .H shall apply to the entire building or structure. It shall be demonstrated that the entire building or structure is capable of resisting these forces and safeguarding the occupants and the public.

Consideraton shall be given to all aspects of construction which may affect safety; including but not necessarily limited to the adequacy of connections between structural members, the adequacy of building separation and the security of unreinforced filler walls as well as parapets and appendages.←

Sec. 204.2 Director may adopt Rules and Regulations. The Director of Public Works may adopt and promulgate rules and regulations supplemental to this Code and not in conflict with the intent therewith. → Such rules and regulations shall be generally accepted or approved methods and practices for the public health and welfare and safety of life, subject to re-examination and change if at any time such rules and regulations are found to be not in conformance with the intent or requirements of the Municipal Code.

The Director may administratively authorize the processing of applications involving Housing Code compliance actions initiated by the Department of Public Works, in a manner other than set forth in this Code, so as to effect said compliance most expeditiously; provided however that due process is assured all applicants. In this regard, the Director may reduce the time periods set forth in Sections 301.C.e, 302.D and 302.D.2 as they apply to a second application required by the Director to effect full compliance with the Housing Code if by so doing compliance with the Housing Code would be more expeditiously accomplished.

Sec. 502.1. Minimum Requirements Applicable for Change of Occupancy. In addition to the requirements of Tables No. 5-D and 5-E, and the specific requirements of the new occupancy as set forth in Articles 6 through 15, where the change of occupancy is permissable under Table No. 5.1, the following requirements shall in all cases be met for the new occupancy in compliance with this Code:

(a) Exit requirements per Article 33 to the public way

(b) Ventilation

(c) Sanitation

(d) Fire extinguishing equipment and protection devices per Article 38.

(e) Lateral force provisions of Section 104.F, if the change of occupancy results in an increased occupant load or floor load.

San Francisco Housing Code

Section 104. Scope.

(f) It is further provided that the Director of Public Works may adopt and promulgate rules and regulations supplemental to this Code and not in conflict therewith, provided they are the most generally accepted or approved methods and practices for public welfare and safety of life and property. Such rules and regulations shall be subject to reexamination and change if at any time such rules and regulations are found by any enforcement agency not to be in conformance with the intent or requirements of the Municipal Code

Sec. 105. Existing Buildings. All buildings erected after July 26, 1958 shall comply either with the codes in effect at the time of construction or the present Building. Electrical, and Plumbing Codes at the discretion of the owner.

All buildings erected prior to July 26, 1958 shall comply with the requirements as set forth in the codes in effect at the time of construction except as otherwise provided herein. The retroactive provisions in Article 3 shall take precedence over any Code provision in effect at the time of construction.

All buildings altered or converted prior to July 26, 1958 which do not conform to the codes in effect at the time of the alteration or conversion and the provisions of this Code shall be reconverted back to the original approved state and brought into compliance with the retroactive requirements applicable to the original structure, or conform to all the applicable requirements outlined in the present codes.

Sec. 801. Ways of Departure. See Articles 1, 13 and 14 of the Building Code.

Way of departure facilities for buildings constructed, altered or converted after July 26, 1958 shall comply with the codes in effect at the time of construction, alteration or conversion, or the provisions of Section 3302.A.1, 3320 and 3320.1 of the Building Code, whichever is the less restrictive, as is applicable to that occupancy.

Way of departure facilities for buildings constructed, altered, or converted prior to July 26, 1958 shall meet the following minimum requirements or the provisions of Sections 3302.A.1, 3320 and 3320.1 of the Building Code, whichever is the less restrictive.

Each of the following buildings, now in existence shall be provided with access for each dwelling unit or guest room to two means of egress which shall be accessible either directly or through a public hallway and shall be so located that if access to one be denied, the other shall be available:

(1) In apartment houses, hotels (and two-family dwellings per Section 3320.1 of the Building Code.).

Where exits are arranged so that one way of departure must be passed to get to the other, intervening doorways between any exit doorway on a dead end corridor more than 20 feet in depth and the main exit corridor shall be provided with a ¾-hour opening protector or a sprinkler head located on the room side of the doorways as well as in the dead end corridor.

(2) Every single family dwelling having more than two floors of occupancy in which there are rental units, shall have not less than two ways of departure from the uppermost stories to a floor of occupancy below which has two ways of departure to the exterior of the building.

Sec. 807. Smoke Barriers. In buildings in which an existing Group H occupancy is located on three or more stories and which does not have a way of departure directly accessible from within each apartment or guest room without entering an exit corridor, every interior public stairway shall be enclosed as set forth in Section 806 of this Code or shall be provided with a smoke barrier and smoke stop door, as hereinafter described, to prevent fire and smoke from spreading, thereby cutting off the way of departure.

An automatic sprinkler system installed in an exit corridor and stairwell and exitway to exterior of building, in accordance with the provisions of Article 38 of the Building Code, will be acceptable in lieu of a smoke barrier.

When a hotel room or apartment opens directly upon the stairway so that the smoke barrier does not afford said room or apartment protection, said hotel room or apartment shall have a one and three-eighths inch solid core wood door, an incombustible surfaced door or other similar approved self-closing device.

The smoke barrier and smoke stop door shall be located where directed by the Superintendent and shall be constructed as follows:

(1) In Type 3 and 5 buildings, the smoke barrier may consist of partitions containing wire glass with solid core wood smoke stop doors. The doors shall be not less than one and three-eighths inch thick, three feet wide, and six feet eight inches high equipped with an approved self-closing device. The smoke barrier may be of any approved similar construction except that wood panels and similar combustible materials shall not be permitted.

(2) In other than Type 3 and 5 buildings, the smoke barrier partitions shall be entirely of incombustible construction except for the smoke stop door and the trim and except that wire glass lights in the partition shall be permitted. The smoke stop door may be an unrated, solid-core wood door not less than one and three-eighths inch thick, three feet in width and six feet eight inches in height equipped with an approved self-closing device and may have wire glass lights therein.

Smoke barrier doors may be held in an open position to allow for the necessary corridor ventilation, provided the means of holding the doors open include a smoke detection device and a

SAN FRANCISCO FIELD INSPECTION MANUAL FOR EXISTING RESIDENTIAL BUILDINGS

Introduction

This manual is to be used as a guide for inspection of residential buildings built prior to July 26, 1958 in determining whether the building is substandard as defined in Article 4 of the 1975 San Francisco Housing Code. This manual does not pertain to non-residential buildings or occupancies except in the case of a mixed occupancy building, then only as violations affect the residential occupancy.

The retroactive provisions of the Housing Code are to be applied to all buildings whenever built, altered, or inspected. See Section 309 of the Housing Code for the list of retroactive sections.

If a requirement other than those retroactive is neglected on permit work done within the last twenty years, it should be provided only when a most serious hazard would result from its absence. The following shall be used as examples of a most serious hazard, but is not intended to be all inclusive: unsafe or obstructed egress; an excess floor of occupancy exists; substantial structural inadequacy exists caused by sagging or deteriorated structural members, or the absence of lateral supports; lack of light and ventilation, the absence of toilet or bath facilities within the dwelling unit, substantial overloading of electrical service or exposed wiring; lack of sprinkler system where required.

If a building was built or converted before twenty years ago under a permit, but some code requirements were neglected, they must be provided if their absence constitutes a *hazard,* including those listed above.

If a building was built or altered without a permit, it must meet the Code standards of the day of its construction or alteration as modified herein, and as provided in the retroactive section of the Housing Code.

Appendix 6—State of California

Revision Record for Register 78, No. 26 (July 1, 1978)

TITLE 25. HOUSING AND COMMUNITY DEVELOPMENT

Part I. Housing and Community Development

Chapter 1. State Housing Law Regulations and Earthquake Protection Law Regulations

Subchapter 1. State Housing Law Regulations

Article 6. Rehabilitation and Repair of Existing Buildings

70. Rehabilitation. Any portion of an existing structure which is subject to the provisions of this subchapter may be altered, repaired or rehabilitated, regardless of the value of the work or the duration of construction period, without the entire structure being made to comply with the requirements of this subchapter for new construction.

72. Plumbing. (a) Any plumbing system may have its existing use, maintenance or repair continued if the use, maintenance or repair is in accordance with the original design and location and no hazard to the public health, safety or welfare has been created by such system. (17922(c) Health and Safety Code, effective date January 1, 1975)

(b) Alterations. In existing buildings or premises in which plumbing installations are to be altered, repaired or renovated, the enforcement agency has discretionary powers to permit deviation from the provisions of this subchapter, provided that such a proposal to deviate is first submitted to the enforcement agency for proper determination in order that health and safety requirements as they pertain to plumbing shall be observed. (17922(c) Health and Safety Code, effective date January 1, 1975)

(c) Building Sewers. Existing building sewers and building drains may be used in connection with plumbing alterations or repairs if such sewers or drains have been properly maintained and were installed in accordance with the applicable laws in effect at the time of installation. (17922(c) Health and Safety code, effective date January 1, 1975)

(d) Existing Plumbing Systems. Any plumbing system shall be deemed to have conformed to applicable law in effect at the time of installation and to have been maintained in good condition if currently in good and safe condition and working properly. (17922(c) Health and Safety Code, effective date January 1, 1975)

74. Mechanical Equipment. Existing mechanical equipment may be used in connection with alterations or repairs if such mechanical equipment has been properly maintained and was installed in accordance with the applicable laws in effect at the time of installation. Any mechanical equipment in existence shall be deemed to have conformed to applicable law in effect at the time of installation and to have been maintained in good condition if currently in good and safe condition and working properly. (17922(c) Health and Safety Code, effective date January 1, 1975)

Except as otherwise noted in Section 17922(c) Health and Safety Code, all alterations, repairs, or additions of mechanical equipment shall conform to Section 48 of this subchapter.

76. Electrical Equipment. Existing electrical systems may be used in connection with alterations or repairs if such electrical systems have been properly maintained and were installed in accordance with the applicable laws in effect at the time of installation. Any electrical system in existence shall be deemed to have conformed to applicable law in effect at the time of installation and to have been maintained in good condition if currently in good and safe condition and working properly.

Alterations, repairs, or additions of electrical equipment shall conform to Section 50 of this subchapter.

78. Regulations for Existing and Relocated Buildings. Regulations governing the alteration and repair of existing and relocated buildings shall be as set forth in Sections 17958.8 and 17958.9 of the Health and Safety Code which reads as follows:

17958.8. HSC. Local ordinances or regulations governing alterations and repair of existing buildings shall, after July 1, 1975, permit the replacement, retention and extension of original materials and the use of original methods of construction as long as the hotel, lodginghouse, motel, apartment house or dwelling, or portions thereof, or building and structure accessory thereto, complies with the rules and regulations of the commission or alternative local standards adopted pursuant to Section 17920.7 and does not become or continue to be a substandard building. (Added Stats. 1974, c. 1268)

17958.9. Local ordinances or regulations governing the moving of apartment houses and dwellings shall, after July 1, 1978, permit the retention of existing materials and methods of construction so long as the apartment

house or dwelling complies with the rules and regulations of the commission or alternative local standards adopted pursuant to Section 17920.7, complies with the standards for foundation applicable to new construction, and does not become or continue to be a substandard building.

Article 7. Structural Fire Safety in Existing Buildings

80. (a) Authority. This article is adopted pursuant to the provisions of Section 17920.7 of the Health and Safety Code.

(b) Purpose. The purpose of these regulations is to provide a reasonable degree of safety to the occupants and the general public in existing multiple-story structures let for human habitation.

82. Application and Scope. Except as otherwise provided in Section 17920.7 of the Health and Safety Code and this subchapter, the provisions of this article shall apply to all existing multiple-story structures let for human habitation including, and limited to, apartment houses, hotels, and motels wherein rooms used for sleeping are let above the ground floor.

84. High Rise Structures. The provisions of this article shall not apply to any existing apartment house, hotel or motel having floors (as measured from the top of the floor surface) used for human occupancy located more than 75 feet above the lowest floor level having building access which is subject to the provisions of Sections B1733 through B1747, Part 2, Title 24, California Administrative Code relating to existing high rise buildings. (T25–84)

86. Inspection of Existing Buildings. The enforcement agency shall inspect every building reported to be in violation of this article, and in addition shall inspect buildings when deemed appropriate to obtain compliance with the regulations. A building which does not comply with the provisions of this article shall be declared to be a substandard building. The enforcement agency shall institute abatement proceedings to correct or abate a substandard building in accordance with the provisions of Section 114 to 144 inclusive of this subchapter.

88. Number of Exits. Every apartment and every other sleeping room shall have access to not less than two exits. A fire escape may be used as one means of egress, if the pitch does not exceed 60 degrees, the width is not less than eighteen inches (18″), the treads are not less than four inches (4″) wide and they extend to the ground or are provided with counterbalanced stairs reaching to the ground. Access shall be by an opening having a minimum dimension of twenty-nine inches (29″) with open. The sill shall not be more than thirty inches (30″) above the floor and landing. (T25–88)

90. Stair Construction. All stairs shall have a minimum run of nine inches (9″) and a maximum rise of eight inches (8″) and a minimum width exclusive of handrails of thirty inches (30″). Every stairway shall have at least one handrail. A landing having a minimum horizontal dimension of thirty inches (30″) shall be provided at each point of access to the stairway. (T25–90).

92. Interior Stairways. Except as provided herein, every interior stairway shall be enclosed with walls of not less than one-hour fire-resistive construction.

Where existing partitions form part of a stairwell enclosure, wood lath and plaster in good condition will be acceptable in lieu of one-hour fire-resistive construction. Doors to such enclosures shall be protected by a self-closing door equivalent to a solid wood door not less than one and three-fourths inches (1¾″) thick. Enclosures shall include landings between flights and any corridors, passageways, or public rooms necessary for continuous exit to the exterior of the building.

The stairway need not be enclosed in a continuous shaft if cut off at each story by the fire-resistive construction required by this Subsection for stairway enclosures.

Enclosures shall not be required if an automatic fire-extinguishing system is provided for all portions of the building except bedrooms, apartments, and rooms accessory thereto.

Interior stairs and vertical openings need not be enclosed in two-story buildings. (T25–92)

94. Exterior Stairway. Existing exterior stairs of noncombustible materials or of wood not less than two-inch (2″) nominal thickness with solid treads and risers may be continued in use provided they are properly maintained. (T25–94)

96. Existing Circular Stairways. Existing circular stairways may be used as an exit when adequately maintained and providing the minimum width of run is not less than 10 inches, and the smaller radius is not less than twice the width of the stairway. The width of treads and height of risers within any flight shall have identical dimension with a ¼ inch tolerance. (T25–96)

98. Existing Winding Stairways. Existing private winding stairways may be used when adequately maintained, provided the required width of run is provided at a point not more than 12 inches from the side of the stairway where the treads are the narrower, but in no case shall any width of run be less than 6 inches at any point. (T25–98)

100. Doors and Openings. Exit doors shall swing in the direction of exit travel, shall be self-closing, and shall be openable from the inside without the use of key or any special knowledge or effort. Doors shall not reduce the required width of stairway more than six inches (6″) when open. Transoms, and openings other than doors, from corridors to rooms shall be fixed closed and shall be covered with a minimum of three-fourths inch (¾″) plywood or ½ inch gypsum wallboard or equivalent material. (T25–100)

102. Swing. Exit doors shall swing in the direction of exit travel when serving any hazardous area or when serving an occupant load of 50 or more. Double acting doors shall not be used as exists serving a tributary occupant load of more than 100; nor shall they be used as a part of a fire assembly, nor equipped with panic hardware. A double acting door shall be provided with a view panel of not less than 200 square inches. (T25–102)

104. Exit Signs. Every exit doorway or change of direction of a corridor shall be marked with a well-lighted exit sign having letters at least 5 inches high. This section shall apply only when the occupant load is in excess of 50 (T25–104)

106. Enclosure of Vertical Openings. Elevators, shafts, ducts, and other vertical openings shall be enclosed as required for stairways in Section 96, or by wired glass set in metal frames. Doors shall be noncombustible, or as regulated in Section 96. (T25–106)

108. Separation of Occupancies. (a) Occupancy separations shall be provided as specified in this subchapter. Lobbies, and public dining rooms not including cocktail lounges, shall not require a separation if the kitchen is so separated from the dining room. Boiler rooms or heater rooms containing a central heating plant using solid or liquid fuel shall be separated from the rest of the building by a One-Hour Fire-Resistive Occupancy Separation.

(b) **Equivalent Protection.** In lieu of separation of occupancies required by Subsection (a), equivalent protection may be permitted when approved by the enforcement agency. (T25–108)

110. Portable Fire Extinguishers. Portable fire extinguishers shall be provided and maintained in every apartment house and hotel in accordance with requirements set forth in this article.

112. Number and Type. The number and type of portable fire extinguishers to be installed shall be determined by the enforcement agency. However, the

minimum requirements shall be as set forth in Title 19, Chapter 1, Subchapter 3, California Administrative Code.

Note. See Section 17920.7, of the Health and Safety Code, which in pertinent part reads: ". . . It is the intention of the Legislature that this section and the rules and regulations adopted by the commission pursuant to this section shall not be more restrictive than the requirements for new construction contained in the Uniform Building Code . . ."

Therefore this article is not applicable to two-story buildings with an occupant load of no more than 10 above ground floor. (See Uniform Building Code, Paragraph 3302(a) 1970 Edition.)

Appendix A. Health and Safety Code Division 13. Part 1.5 State Housing Law

Chapter 1. General Provisions

17912. Rules and regulations promulgated pursuant to the provisions of this part, relating to the erection or construction of buildings or structures, shall not apply to existing buildings or structures or to buildings or structures as to which construction is commenced or approved prior to the effective date of the rules or regulations, except by act of the Legislature, but regulations relating to use, maintenance, and change of occupancy shall apply to all hotels, motels, lodginghouses, apartment houses, and dwellings, or portions thereof and buildings and structures accessory thereto, approved for construction or constructed before or after the effective date of such rules or regulations. (Amended Stats. 1974, c. 1268)

Chapter 2. Rules and Regulations

17920. As used in this part:

(f) "Substandard building" means any building or any portion of a building including, buf not limited to, any dwelling unit, guest room, or suite of rooms, or the premises on which the same is located, in which there exist any of the conditions listed in Chapter 10 of the Uniform Housing Code, latest edition, including inadequate structural resistance to horizontal forces, to an extent that endangers the life, limb, health, property, safety, or welfare of the public or the occupants thereof.

However, a condition which would require displacement of sound walls or ceilings to meet height, length, or width requirements or ceilings, rooms, and dwelling units shall not by itself be considered sufficient existence of dangerous conditions making a building a substandard building, unless the building was contructed, altered, or converted in violation of such requirements in effect at the time of construction, alteration, or conversion.

Any wiring, plumbing, or mechanical equipment, including vents, shall be deemed to have conformed to applicable law in effect at the time of installation and to have been maintained in good condition if currently in good and safe condition and working properly.

17920.6. As used in this part, "housing appeals board" means the board or agency of a city or county which is authorized by the governing body of the city or country to hear appeals regarding the requirements of the city or county relating to the use, maintenance, and change of occupancy of hotels, motels, lodginghouses, apartment houses, and dwellings, or portions thereof, and buildings and structures accessory thereto, including requirements governing alteration, additions, repair, demolition, and moving of such buildings if also authorized to hear such appeals. In any area in which there is not such a board or agency, "housing appeals board" means the local appeals board having jurisdiction over such area.

17920.7. (a) The commission shall adopt, amend, repeal, and except as otherwise provided in this part, enforce rules and regulations for the provision of structural fire safety and fire-resistant exists in existing multiple-story structures let for human habitation including, and limited to, apartment houses, hotels and motels wherein rooms used for sleeping are let above the ground floor. The rules and regulations shall provide adequate safety to the occupants and the general public, and shall impose the same requirements as are contained in subdivisions (d), (e), (f), (g), (h), (i), (k), and (l) of Section 1313 of Chapter 13 of the appendix of the Uniform Building Code, 1970 edition, as adopted by the International Conference of Building Officials.

The commission, after consultation with the State Fire Marshal, may adopt reasonable exceptions to subdivisions (e) and (g) of Section 1313 to permit the continued use of existing stairs and to subdivision (l) of Section 1313 to permit equivalent protection in lieu of occupancy separations. However, such exceptions shall not impair occupant safety and shall be consistent with the legislative intent of this section.

Interior stairs and vertical openings need not be enclosed in two story buildings.

(b) Notwithstanding the provisions of subdivision (a), any city, county, or city and county may adopt standards for structural fire safety and fire-resistent exists in structures subject to the provisions of this section, provided that such standards are substantially equivalent in fire safety to the standards adopted by the commission pursuant to subdivision (a). Each city, county, or city and county adoping such alternative standards shall submit a detailed statement, with supporting data, to the Director of Housing and Community Development demonstrating the equivalency of the alternate standards. The Director of Housing and Community Development shall make a finding as to the equivalency of alternate local standards to state standards. It is the intention of the legislature that this section and the rules and regulations adopted by the commission pursuant to this section shall not be more restrictive than the requirement for new construction contained in the Uniform Building Code, 1970 edition, as adopted by the International Conference of Building Officials.

17921. The commission shall adopt, amend, repeal, and, except as hereinafter provided, the department shall enforce rules and regulations for the protection of the public health, safety, and general welfare of the occupant and the public governing the erection, construction, enlargement, conversion, alteration, repair, moving, removal, demolition, occupancy, use, height, court, area, sanitation, ventilation and maintenance of all hotels, motels, lodging houses, apartment houses, and dwellings, and buildings and structures accessory thereto. Such rules and regulations may include a schedule of fees to pay the cost of enforcement by the department under Sections 17952 and 17965. (Amended Stats. 1974, c 1268)

17922. (c) Regulations governing alteration and repair of existing buildings and moving of apartment houses and dwellings shall permit the replacement, retention, and extension of original materials and the continued use of original methods of construction as long as the hotel, lodging house, motel, apartment house, or dwelling, or portions thereof or building and structure accessory thereto, complies with the rules and regulations of the commission or alternative local standards adopted pursuant to Section 17920.7 and does not become or continue to be a substandard building. Building additions or alterations which increase the area, volume, or size of an existing building, and foundations for apartment houses and dwellings moved, shall comply with the requirements specified in this part, or in rules and regulations adopted pursuant to this part, for new buildings or structures. However, such

additions and alterations shall not cause the building to exceed area or height limitations applicable to new construction.

Chapter 4. Application and Scope

17958.8. Local ordinances or regulations governing alterations and repair of existing buildings shall, after July 1, 1975, permit the replacement, retention and extension of original materials and the use of original methods of construction as long as the hotel, lodging house, motel, apartment house or dwelling, or portions thereof, or building and structure accessory thereto, complies with the rules and regulations of the commission or alternative local standards adopted pursuant to Section 17920.7 and does not become or continue to be a substandard building. (Added Stats. 1974, c. 1268)

17958.9. Local ordinances or regulations governing the moving of apartment houses and dwellings shall, after July 1, 1978, permit the retention of existing materials and methods of construction so long as the apartment house or dwelling complies with the rules and regulations of the commission or alternative local standards adopted pursuant to Section 17920.7, complies with the standards for foundation applicable to new construction, and does not become or continue to be a substandard building.

APPENDIX 11

Southern Building Magazine, February/March 1980; "Rehabilitation of Existing Buildings: An Achievable Goal" by William J. Tangye, P.E.

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Rehabilitation of Existing Buildings: An Achievable Goal

The cover of this issue of the "Southern Building" magazine acknowledges 40 years of service by the Southern Building Code Congress to the building community. During these 40 years the south in particular and the nation in general have undergone a tremendous building boom, the results of which are the existing buildings of today that form one of our most important, yet least recognized, resources.

It seems appropriate, therefore, to reflect upon both the code requirements of the past 40 years and those existing buildings that were designed and constructed to meet those requirements. It is recognized that these existing buildings may not comply with all the requirements of today's codes, yet, at the time of their construction, they complied with the applicable codes and standards and in most cases have stood the test of time by serving their intended use in a safe and satisfactory manner.

The fact that these buildings, for the most part, have performed their intended function is sufficient to justify their rehabilitation and/or reuse. It is imperative—if we are to achieve the goal of rehabilitating our existing building stock—that a concerted effort be made by code enforcement personnel, local governments and others involved in the building community to encourage and find the means to facilitate this activity.

Codes and Enforcement Today

Today's codes and code enforcement techniques are being criticized in the belief that both impede if not discourage the rehabilitation of existing buildings. Much of this criticism is not valid. There are some aspects, however, that ring true and these aspects should be considered by us as a challenge to prove that rehabilitation of existing buildings can be accomplished in a timely and beneficial manner using the present codes enforcement process. The accomplishment of this challenge may require modifications to both codes and enforcement techniques but more important, it will require a change in attitudes about building rehabilitation.

In order to adapt a code enforcement program to include the rehabilitation of existing buildings, we need to briefly review how the present system works.

Applicable Building Regulations

Existing buildings are, in general, regulated by one of the following methods:

1. Standard Building Code—Sections 101.4(a) through (d) covers existing buildings that are to be altered or repaired or that have been damaged, but the occupancy classification of the rehabilitated building will not be changed. The requirements contained in these sections are commonly referred to as the 25–50% rule. Section 101.4(e) covers existing buildings that undergo a change in occupancy classification.

2. Standard Code for the Elimination or Repair of Unsafe Buildings—This code deals with existing buildings that represent an imminent hazard to life as defined in Section 201.3. This code is "building" rather than "occupancy" oriented and mandates that unsafe conditions be abated or that the building be demolished.

3. Standard Housing Code—This code deals only with existing Group R—residential occupancies and focuses primarily on health and safety issues and contains requirements aimed at maintaining the buildings in a habitable condition. It should be noted that the requirements in the housing code may be less than those required in new building construction.

4. Standard Fire Prevention Code—This code deals primarily with the maintenance of the life safety features of a building such as means of egress, fire protection systems, alarm systems and the handling and storage of hazardous or flammable materials. This code applies to all occupancy classification.

The above codes, with the exception of the Standard Building Code, deal with the maintenance of existing buildings in a safe and healthful manner and generally promote the continued use of our existing building stock. The Standard Building Code, on the other hand, is primarily directed toward new construction and even though it contains performance language such as Section 103.6—Alternate Materials and Alternate Methods of Construction, it also contains requirements such as those in Section 101.4 that may not in all cases encourage the rehabilitation of existing buildings.

It is my opinion that relatively few and minor changes would have to be made to the Standard Building Code to facilitate the rehabilitation of existing buildings. Accordingly, the remainder of this article will deal one with the Standard Building Code.

Before discussing modifications to the Standard Building Code, it should be emphasized that rehabilitation of existing buildings falls into two distinct categories. The first category includes existing buildings that are to be altered or repaired but in which no change of occupancy classification is contemplated. The second category contemplates that an existing building will undergo a change in occupancy classification.

These categories also comprise the two major criticisms of today's building codes relative to rehabilitation of existing buildings—the 25–50% rule and the categorical requirement that when the occupancy classification of an existing building is changed, the building must be made to conform to the code requirements for the new occupancy classification.

The 25–50% Rule

Let's consider first the 25–50% rule which is contained in Sections 101.4(a) thru (d) of the Standard Building Code and requires the following:

1. If an existing building is to be repaired or altered and the cost of such work done in any 12 month period exceeds 50% of the value of the building, the entire building must be brought up to current code requirements.

2. If an existing building is to be altered or repaired and the cost of such work done in any 12 month period is more than 25% but less than 50% of the value of the building, the building official must determine to what extent the building must be brought up to current code requirements.

3. If an existing building is to be altered or repaired and the cost of such work done in any 12 month period is less than 25% of the value of the building, the building need not be brought up to current code requirements.

4. If an existing building is damaged and the damage exceeds 50% of the value of the building, the building must be brought up to current code requirements. it is implied though not expressly stated that if the damage is less than 50%, the stipulations of items 2 and 3 above would apply.

The strict application of these requirements may discourage the rehabilitation of existing buildings for the following reasons:

1. There is no clear and concise definition of how to establish or what should be considered when established—the value of a building.

2. The percentages are arbitrary and have no basis in fact, thus making them difficult to enforce, particularly if court action is involved.

3. The value of a building will vary with not only the more traditional considerations of size, type of materials, occupancy, etc. but with the geographical location within a governmental jurisdictions boundaries, thus making the requirements potentially discriminating.

Deleting the Rule

Based on the preceding discussion one might conclude that the deletion of the 25–50% rule is the only answer to achieve the goal of rehabilitation of existing buildings. This is one alternative, but such radical action may not be necessary. If, for instance, the 25–50% rule were deleted in favor of some other wording, those buildings that presently fall in the category of less than 25% of the value of the building and are not required to meet the current code, would then have to comply with the new wording. It has not been shown that the "less than 25%" figure has resulted in unsafe buildings, neither has it been a deterrent to rehabilitation. The criticism has been with the higher percentages and the accompanying requirement for full or partial compliance with current code requirements. Therefore, deleting the rule would penalize a certain percentage of rehabilitation work now being accomplished. Another alternative might be to revise the percentage to say 33–66% to permit more rehabilitation work without having to comply with current code requirements. However, this is nothing more than juggling numbers and the new numbers have no more basis in fact than the old numbers. It might also be appropriate to reduce the time span from 12 months to 6 months, which would permit twice the amount of rehabilitation work before triggering compliance with current code requirements. A final alternative would be to remove the requirement for having to bring the entire building up to current code requirements and give the building official the authority to determine which requirements apply.

If a community chooses to maintain the 25–50%, which can be a viable option, the following are recommendations for modification to the rule that will encourage rehabilitation:

General Recommendations

1. Encourage a flexible interpretation of the rule.

2. Define the cost of rehabilitation to exclude all non-permit items such as painting, decorating, cabinets, land-scaping, kitchen and domestic appliances, architects, engineers or contractors fees and all items that would require a separate permit such as plumbing, mechanical and electrical.

3. Define the building value as the current replacement cost after rehabilitation. Do not use assessed valuation since it is usually out of date and may not reflect accurate replacement costs.

4. Revise time span to 6 months.

Specific Recommendations

1. Add a new definition to Section 201.2 to read as follows: COST OF REPAIR, ALTERATIONS OR REHABILITATION, means the cost of repairs, alterations or rehabilitation as used in Section 101.4 and shall include only those items that are regulated by this code and shall not include non-permit items such as painting, decorating, cabinets, land-scaping, appliances not regulated by this code, architects, engineers or contractors fees, nor shall it include items that require a separate permit such as plumbing, mechanical or electrical work.

2. Delete present definition of valuation or value and substitute the following: BUILDING VALUE, means the current replacement cost of a building after repair, alteration or rehabilitation.

3. Delete Sections 101.4 (a) thru (d) and substitute the following: 101.4—EXISTING BUILDINGS (a) If, within any six(6) month period, alterations, repairs or rehabilitation work costing in excess of fifty (50) percent of the building value is made to an existing building, such alterations, repairs or rehabilitation work and the remaining portions of the building shall be made to conform to the requirements of this code for new construction to such extent as may be determined by the building official. (b) If within any six (6) month period, alterations, repairs or rehabilitation work costing in excess of twenty-five (25) percent but not more than fifty (50) percent of the building value is made to an existing building only the portions that are altered, repaired or rehabilitated shall be made to conform to the requirements of this code for new construction, to such extent as may be determined by the building official. (c) Buildings damaged by fire or other causes, and that are to be repaired or rehabilitated shall comply with the provisions of Section 101.4 (a) and (b). (d) The building value shall be established by the building official.

If a local government felt that the 25–50% rule in either its present state or as modified above was not adequate to encourage rehabilitation of existing buildings, the following wording could be used:

Delete present Sections 101.4 (a) thru (d) and substitute the following: 101.4—EXISTING BUILDINGS (a) Alterations, repairs or rehabilitation work may be made to any existing building without requiring the building to comply with all the requirements of this code provided that the alteration, repair or rehabilitation work conforms to the requirements of this code for new construction. The building official shall determine, subject to appeal to the Board of Adjustments and Appeals, the extent if any to which the existing building shall be made to conform to the requirements of this code for new construction. (b) Alterations, repairs or rehabilitation work shall not cause an existing building to become safe as defined in Section 103.4.

This latter type of wording is more broad in scope and will encourage rehabilitation work. However, it would be emphasized that if this course of action is taken, it will require that the owner, his architect or engineer and the code enforcement personnel work closely from project inception to completion to assure that all work will provide the necessary degree of life safety. Under this type of procedure, as well as any other involving the rehabilitation of existing buildings, all parties are encouraged to seek innovative solutions to code related issues. The key is not that the solution comply with the exact code wording but

rather that it achieve a level of safety consistent with that implied by the code.

Change in Occupancy

Consider Section 101.4(e) of the Standard Building Code which deals with changes in occupancy classification of existing buildings. This section requires that any time the occupancy classification of an existing building is changed, the building must be made to conform to the current code requirements for the new occupancy. It is obvious that this type of requirement poses a real roadblock to rehabilitation of existing buildings. Such compliance may not even be attainable considering that specific code language and the cost of attaining compliance, if possible, is often prohibitive. As a result, the rehabilitation work is done illegally or it is not done at all. Consequently, a building may be undesirable or, in the worst case, abandoned.

One of the arguments in favor of this type of specific wording is that if we do not require compliance with the current code when a change of occupancy classification is planned, we are establishing a double standard for existing and new construction. The concern of establishing a double standard is valid but can be resolved to the benefit of all of the local government wants to make the rehabilitation of existing buildings a reality. If we consider that modern building codes reflect the state of the art in building construction, new buildings constructed today should reflect this technology to insure that it is made available to the public. This is not to imply, however, that existing buildings lawfully occupied but not meeting the specific requirements of the current code are less than safe. These existing buildings, as discussed earlier, were built to some code or standard that reflected the state of the art at the time. If they have performed their intended use without exposing the public to any undue hazard, one must conclude that they are safe even though they may not in all respects comply with current codes. This is not consistent to require compliance with current code requirements in order to rehabilitate an existing building even though a change in occupancy classification may be involved. Further, not requiring compliance with current codes is not establishing a double standard but is instead recognizing the life safety required by past codes.

A point that should be made is that an existing building that is lawfully occupied may remain in its present condition and occupancy even though it does not comply with current codes for that occupancy. This is called a "non-conforming right". The occupancy of this building is contingent upon the assumption that there are no imminent hazards in the building. Even if there were hazardous conditions, the code only requires that the hazards be removed but does not require that the building be brought into compliance with the current code.

What the Standard Building Code is trying to accomplish in a change of occupancy classification in an existing building is to provide the equivalent level of health and safety to that prescribed for new construction. To accomplish this task, code enforcement personnel must research the intent of the various code requirements, not just rely on the specific wording. Alternate solutions and innovative methods to meet this intent in existing buildings can then be developed.

Thus, it can be seen that we are not dealing with a double standard, but simply more than one way to achieve the code goal of safety. We do much the same thing on new buildings. If an alternate solution to a specific code requirement is proposed that will achieve an equivalent level of safety to that specified, it can be approved under Section 103.6. If the concept is valid for new buildings, it is equally valid for existing buildings.

The concept of dealing with existing buildings undergoing a change in occupancy classification, and not requiring that the building be brought into compliance with current code requirements, will require that each building be individually evaluated by the code enforcement personnel to determine those areas of the building that need to be modified. It then becomes the responsibility of the owner or his agent to develop methods of accomplishing the modification within the framework of the building and the level of safety required. This process is shown graphically in Figure 1.

In order for this type of system to work, several things must be done other than a change in code wording. Perhaps the most important item is that the local government must be totally committed to the system. The local government should reflect its commitment by adopting a statement that could read as follows:

1. "The (legislative body) finds that the public health, safety and welfare is in part dependent on the conservation, rehabilitation and reuse of the existing building stock, including both residential and other buildings; that the strict application of new construction requirements and standards to the rehabilitation of existing buildings undergoing a change in occupancy may not result in the most timely and beneficial results; that rehabilitation is a major mechanism for increasing the health and safety in existing buildings; and that adequate resources in the form of public and private initiatives exist to increase and expand the incidence of rehabilitation.

"It is therefore the intent of this legislative body, to the maximum extent consistent with minimum standards of human health and safety.

"(1) to promote the rehabilitation of existing buildings by allowing for differences between rehabilitation and new construction in the application of the requirements and standards of this code as long as the equivalent level of safety can be achieved;

"(2) to encourage in rehabilitation the utilization of innovative and economical materials and methods of construction, to provide the level of safety; and,

"(3) to encourage the agencies charged with enforcement of codes, and the officers thereof,

"(i) to apply the provisions of the code to rehabilitated buildings in a manner consistent with the purposes stated herein; and,

"(ii) to exercise discretion and employ resourcefulness in the evaluation of code compliance of rehabilitated structures, in a manner consistent with the purposes stated herein."

In addition to the policy statement, the local governing body needs to be aware of the fact that there are no easy rules to follow in developing or approving innovative solutions to code intent and that disagreement may arise as to the most desirable course of action even when all parties are following the policy statement. Accordingly, it is advisable to establish a rehabilitation advisory board to review the methods and solutions proposed and to determine which course of action should be approved. This responsibility can be assigned to the board of adjustments and appeals which most local jurisdictions already have in existence.

It is imperative also that the local governing body provide protection for the code enforcement personnel from legal action that may arise out of the enforcement of rehabilitation concepts. Since a program, as outlined above, must deal in generalities rather than specifics, as the code does for new construction, this protection is absolutely necessary to free the code enforcement personnel from personal liability.

Recommendation

1. Adopt an ordinance or add to the building code a section to read as follows:

"All officers and employees of (the state, or local jurisdiction, as applicable) charged with enforcement of) state or municipal law generally, or specifically enumerated laws such as building codes) shall be relieved of all personal liability for all damage that may accrue to persons or property and for all costs, including attorney's fees, reasonably necessary to defend against litigation resulting from any act required or permitted in the discharge of official duties and exercised in good faith without malice or intentional wrongdoing. Pursuant to this section, the (jurisdiction) may purchase insurance to indemnify itself, its officers, and its employees from legal liability and defense costs. If insurance is not purchased or available, a suit instituted against an officer or employee for conduct arising out of the lawful discharge of official duties shall be defended by the (legal representative of the jurisdiction, e.g., city attorney) until the final termination of the proceedings, and the (jurisdiction) shall be liable for all costs reasonably necessary to defend such action and for all resulting judgments against the officers and employees based on the good faith discharge of said official duties."

The last item to be accomplished is a modification to Section 101.4(e) that will provide the building official with the authority to approve alternate solutions to code requirements when a change of occupancy classification to an existing building is contemplated.

Recommendation

Delete Section 101.4(e) and substitute the following:

(e) If the occupancy classification of an existing building is changed, the building shall be made to conform to the intent of this code for the new occupancy classification as established by the building official.

Once the changes to the code text as outlined for the 25–50% rule and the change in occupancy have been made and the policy statement and legal statement adopted, the basic framework for a workable rehabilitation program is in place.

The actual rehabilitation of an existing building is not a simple task and will require careful study and application of code intent. There are no manuals or books that will provide acceptable alternate solutions or tradeoffs to every code item and, as such, these solutions will have to be developed as they arise on an individual basis by each code enforcement agency.

There is, however, some valuable information contained in the "Draft Rehabilitation Guidelines" published by the Department of HUD, in the Federal Register, Vol. 44, No. 215, Monday, November 5, 1979. This document, which was prepared in part by the model code groups, has been prepared as a voluntary guideline to be used by local governments in rehabilitation programs and certain information in this article was drawn from it. Copies may be obtained by writing the Dept. of HUD, Division of Energy, Building Technology and Standards, Room 8164, Washington, D.C. 20410.

There are also several cities that have implemented rehabilitation programs. These include Los Angeles, California; San Francisco, California; Denver, Colorado; and Washington, D.C. Copies of these programs should be requested from the building departments in each city. Also, the SBCCI is preparing a manual for code enforcement personnel involved in the inspection of existing buildings for rehabilitation. The manual will contain a discussion of general considerations and more specific sections on materials, construction methods, equipment and planning factors and will include possible corrective measures. For more information on the Rehab Inspection Manual, contact Bill Manning, P. E. or Al Moffitt, R. A. at the SBCCI headquarters.

The SBCCI Technical Department will provide plan examination service on existing buildings that are to be rehabilitated. This review service will be provided for active members and each such review must be accompanied by a letter of authorization from the active member, a copy of the plans, a description of all work to be done to the building, its intended occupancy, structural calculations and a copy of the building department's inspection report on the building. For more information on this service, contact W. J. Tangye, P. E. at the SBCCI headquarters.

BIBLIOGRAPHY

I. Existing or Proposed Rehabilitation Guidelines and/or Codes

- BOCA, "Code Enforcement Guidelines for Residential Rehabilitation," 1975
- Massachusetts State Building Code, Article 22, "Repair, Alteration, Addition and Change of Use of Existing Buildings," June 1, 1979
- City and County of San Francisco, "Field Inspection Manual for Existing Residential Building," November 6, 1970, Revised May 26, 1978

II. Congressional Reports and Other Congressional Documents

- House of Representatives, "Conference Report: Housing & Community Development Amendments of 1978," 95th Congress, 2nd Session, Report #95–1792
- Senate Committee on Banking, "Housing and Community Development Amendments of 1978," May 15, 1978, Report #95–871
- Senate Committee on Banking, "Hearing: Impact of Building Codes on Housing Rehabilitation," March 24, 1978

III. Other Reports and Documents

- Robert Kapsch, "Building Codes: Preservation and Rehabilitatioin," "Research and Innovation in the Building Regulatory Process," NBS Special Publication 473, pp. 437–452, June 1977
- Baird Smith, "Information Structure of Building Codes and Standards for the Needs of Existing Buildings," NBS Special Publication 473, pp. 453–485, June 1977
- Russell Keune, "Assessment of Current Building Regulatory Methods as Applied to the Needs of Historic Preservation Projects," NBS Special Publication 524, October 1978
- John Habraken, "An Investigation of Regulatory Barriers to the Re-Use of Existing Buildings, NBS GCR 78–139, January 1978
- National Trust for Historic Preservation, "Preservation and Building Codes," Preservation Press, 1975
- Keune, McCune, Kapsch, "Building Codes for Preservation," Preservation News Supplement, November 1976
- Green & Watson, "Alternative Life Safety Systems for Historic Structures," National Endowment for the Arts, 1976
- Gardiner, et al., "Corruption in Land Use and Building Regulation," "Law Enforcement Assistance Administration," Grant Number 76–NI–99–0087, January 1978
- Rogg, "Urban Housing Rehabilitation in the United States," U.S. League of Savings Associations
- HUD "Guidelines for Rehabilitating Old Buildings," April 1977
- HUD 4940, "Minimum Design Standards for Rehabilitation"
- Gross, Pielert, Cooke, "Impact of Building Regulations on Rehabilitation—Status and Technical Needs," NBS Technical Note 998, May 1979
- Kapsch, Brenner, Hattis, "The HUD Rehabilitation Guidelines Program," paper presented to the NBS/NCSBCS Conference on Rehabilitation Technology, December 1979
- Kapsch, "HUD's Rehabilitation Guidelines: Cracking the Codes," Chicago Title Insurance Company *Guarantor*, March/April 1980
- Green, Cooke, "Survey of Building Code Provisions for Historic Structures," NBS Technical Note 918

Guideline for Approval of Building Rehabilitation

Introduction

Most communities have laws, regulations and codes which govern the construction and use of buildings. This

regulatory system involves an approval process which consists of three distinct functions:

- Construction permits (prior to construction)
- Construction inspections (during construction)
- Maintenance inspections (throughout a building's life)

This process is used to regulate both new building construction and rehabilitation of existing buildings. In the case of rehabilitation, where parts of an existing building remain, the first two functions (construction permits and construction inspections) often involve delays, additional paper work, cost increases and other adverse effects, because of problems such as the following:

- characteristics of existing materials or equipment (e.g., strength, capacity, etc.) cannot always be determined accurately;
- materials, equipment or methods of construction may be concealed from view and cannot be determined except by partial demolition;
- the size (e.g., height, width, thickness, length or shape) or location of existing building parts which are to remain may preclude design or construction solutions specifically covered by codes or regulations; and
- complete designs or accurate scopes-of-work cannot always be made prior to the start of construction.

The new construction approval process is well known to everyone in the industry, and it functions efficiently. For rehabilitation, however, it is less well known and it functions less efficiently. This guideline is intended to assist communities in improving the rehabilitation approval process.

To fulfill this intent, the following portion of the guideline has been organized according to the functioning of the approval process, in five sequential steps:

Step 1. Outreach Program
Step 2. Preliminary Review
Step 3. Construction Permits
Step 4. Construction Inspections
Step 5. Maintenance Inspections

The discussion of steps 2 through 5 compares rehabilitation to new building construction to emphasize the special considerations for rehabilitation and to facilitate rehabilitation by suggesting improvements in its approval process.

Step 1. Outreach Program

An outreach program which clearly explains a community's approach to rehabilitation helps design professionals, contractors and building owners. It may also help code enforcement personnel, since those whom they serve will be better informed. While outreach is not strictly a part of an approval process, it is an essential part of a comprehensive regulatory program to encourage rehabilitation.

A rehabilitation outreach program should have two basic interrelated features:

- providing building owners, design professionals and contractors with information about rehabilitation and its approval process, and
- making those authorities having jurisdiction over a rehabilitation approval process more accessible to building owners, design professionals and contractors.

A program of information dissemination might use any one or combination of the following opportunities in conjunction with improved access to rehabilitation authorities:

- radio or television "spot" announcements;
- newspaper advertisements;
- adult education and professional continuing education courses, workshops and conferences; and
- free literature at banks, libraries, government offices and "do-it-yourself", lumber and hardware stores.

Portland, Oregon, for example, has used television "spot" announcements effectively.

An outreach rehabilitation program should provide information regarding:

- permits required, and how, when, and where to obtain them;
- technical requirements and regulations governing rehabilitation;
- necessary construction inspections, and when they must occur;
- related regulatory and procedural matters; and
- how, when and where to obtain more information.

Increased accessibility to the authorities having jurisdiction over the rehabilitation approval process is not only a means to help those interested in rehabilitation to secure information more easily, but it is also a means to improve the rehabilitation process itself. A community might use any one or combination of the following opportunities:

- assign one or more regulatory personnel to handle all rehabilitation projects;
- locate all code permit functions in one office space or building when multiple permits are required;
- issue one permit instead of multiple permits;
- use neighborhood offices rather than a central office for the approval process;
- hold open houses at the authorities; offices; and
- extend the hours of the authorities' office operation to evenings and Saturdays so as to be more accessible to homeowners.

Seattle, Washington, for example, has assigned one plan check engineer to handle all rehabilitation; and this, it is felt, provides continuity, familiarity with problems unique to rehabilitation and a reduction in the number of formal appeals. Portland, Oregon, has instituted a regularly scheduled "homeowners' evening" at the building department to improve accessibility.

An effective rehabilitation outreach program facilitates the subsequent steps of the approval process.

Recommendation

Develop a rehabilitation outreach program related to the community's approval process, and specifically designed to meet its needs.

Step 2. Preliminary Review

New Buildings

Preliminary reviews are becoming more widely accepted by communities. They are the real first step in the approval process for new building projects, and consist of an examination with the authorities having jurisdiction of the design, construction and codes issues related to those projects. It may be a formal, official review or an informal, unofficial one. As preparation for the mandatory steps following, this step should be taken at the earliest possible time, and should involve all the authorities in a community concerned with a project. Its aim is to get the project started "on the right foot".

Some authorities having jurisdiction are not the least reluctant to participate on- or off-the-record in the preliminary review of projects. They recognize that in the next steps of the approval process their participation is mandatory. These authorities understand that the purpose of this initial step is to solve potential problems before they become real problems and to expedite the approval process, thereby reducing delays, paperwork and costs.

For new building construction, the preliminary review is usually a meeting (or a series of meetings on larger and more complex projects). Preferably, the meeting will include not just the building department but all the jurisdictional bodies concerned with a project (e.g., planning, zoning, design review, historic preservation, fire health, traffic, etc.).

In Bloomington, Minnesota, for example, the Fire and Life Safety Committee meets on a regular schedule and has members from every concerned jurisdictional body. The committee participates in formal preliminary reviews of all projects.

At the conclusion of the preliminary review, a general and clear understanding about the following is usually established:

- code applicability to a proposed new building's use and occupancy with regard to existing site conditions and proposed building plan layouts, heights, areas, materials, equipment and construction methods;
- mandatory inspections;
- permit fee schedules;
- forms and applications which must be obtained from all the concerned jurisdictional bodies; and
- possible items of non-compliance with the codes for which a modification may need to be sought now or in the construction permit step through the formal appeals process (see *Statutory Guideline for Building Rehabilitation).*

Usually, only very preliminary drawings and outline specifications are necessary for a preliminary review. Even concept drawings, rough sketches and material lists may be enough for simple buildings. For industrialized buildings, producers' literature may provide adequate information.

Rehabilitation

Preliminary review for rehabilitation projects is much the same as that for new construction, but there are important differences in its purpose, and in the way its procedures should be implemented.

In addition to expediting the approval process and solving potential problems before they become real ones, the preliminary review for rehabilitation has three purposes:

- to establish or clarify an owner's intent and proposed scope-of-work (e.g., change of occupancy, change of use, extent of construction, etc.), in order to clarify the code implications of the program;
- to determine the specific applicable code requirements and whether in fact pemits are needed; and
- to establish an acceptable rehabilitation program, including the definition of any alternative or equivalent design or construction solutions to code requirements which may be necessary.

If an owner has enough information about the building to be rehabilitated, a preliminary review may only require a single meeting. In larger, more complex projects or when necessary information is not available at the first meeting, two or more meetings may be required.

In the latter circumstance, necessary information should be obtained by either the first or both of the following investigation procedures:

- a search by jurisdiction personnel of the records of all the jurisdictional bodies concerned with the past and present occupancy of the building to be rehabilitated; and
- an on-site investigation of the existing building by qualified jurisdiction personnel or by private engineers and architects.

An on-site investigation of an existing building may consist of any one or combination of the following:

- an assessment of the physical context of a building to determine the acceptability of some proposed rehabilitation solutions such as those suggested in the *Plumbing DWV Guideline for Residental Rehabilitation* (e.g., single stack DWV solutions are not recommended for use where a sewer system is subject to flooding) or the *Egress Guideline for Residential Rehabilitation* (e.g., certain egress solutions may depend upon accessibility of the building to the fire department);
- a determination by observation of such physical conditions of an existing building as structural integrity, electrical equipment damage, the number of electrical receptacle outlets or the number of stories, suites, rooms or exits;
- a determination by measurement and/or calculation (which may in some cases require selected demolition; see Step 3. Construction Permits of this guideline) of such physical characteristics of an existing building as area, height, plumbing DWV piping sizes, electical conductor sizes, electrical load-carrying capacity, sizes of structural members, composition of fire resistant assemblies and fire resistance ratings, or widths and lengths of exitways;
- a determination by testing of the adequacy of function or performance level of such parts of an existing building as plumbing DWV piping, electrical equipment and devices, or archaic materials and assemblies for fire resistance.

See the *Electrical Guideline for Residential Rehabilitation,* the *Plumbing DWV Guideline for Residential Rehabilitation,* the *Egress Guideline for Residential Rehabilitation* and the *Guideline on Fire Ratings of Archaic Materials and Assemblies* for more detailed discussions of on-site investigation methods.

It is important to note that any imminent hazard found in the investigation should be reported to the authority having jurisdiction for enforcement of applicable regulations.

When the investigation has obtained all the necessary information, a second preliminary review meeting (or series of meetings if required) can take place. The understandings reached and the conclusions made at the end of this step for rehabilitation concern the same subjects as those for new building construction. However, in those jurisdictions which issue construction permits, it may be concluded that unlike new construction, some rehabilitation projects do not require construction premits. This decision by an authority having jurisdiction will take into account such factors as the quantity of rehabilitation work, the safety and health implications of the work, and whether a change of occupancy or use is involved.

Many rehabilitation projects will require essentially the same types of drawings, sketches, specifications or material lists as new building construction. In some instances, one line diagrams or system schematics will be necessary for testing during a field investigation (see the *Plumbing DWV Guideline for Residential Rehabilitation*) 1or for clarifying existing conditions. For simpler or less extensive rehabilitation, a written description of the scope-of-work may be all that is necessary.

Recommendations

- Initiate a Preliminary Review step for rehabilitation, or modify the current Preliminary Review procedure used for new buildings.
- Develop on-site investigation procedures for existing buildings which are based on the nature of the community's building stock.

Step 3. *Construction Permits*

New Buildings

There are three basic types of construction permits for new buildings, used for three distinct circumstances:

- a Full Pemit is used when there is enough information about the total scope of a project's work;
- a Partial Permit is used in some communities when there is enough information about only a part of the total scope of a project's work; and
- a Conditional Permit is used in some communities when there is not enough information to issue a Full or Partial Permit, but construction can begin

safely on a portion of the work and can be completed when the mission information is determined and formally approved.

New building construction may have a series of Partial Permits (e.g., excavation, foundations, superstructure, sewer hook-up, etc.) which together equal a Full Permit when the last Partial Permit is issued. Partial Permits necessitate a series of permit applications, plan reviews, and permit issuances. The total of Partial Permit fees usually exceeds the fee for a Full Permit.

Permit application and issuance is a formal, official step in the approval process which is carred out under the auspices of the authorities having jurisdiction. For the construction permit, it consists of three stages:

- a formal application to the authorities having jurisdiction;
- a formal plan review of the construction permit application, and approvals by other jurisdictional bodies (e.g., zoning board, health department, etc.) if required; and
- the issuance or "filing" of the construction permit(s) upon approval of the application.

In new building construction, the construction documents needed for the application and plan review usually consist of detailed construction drawings (working drawings) and specifications. Approval of these construction documents in the plan review may be withheld if some portion of the proposed work is not in compliance with the applicable code(s), or if the construction documents are inadequate in some way.

In the case of non-compliance, an applicant can either change the proposed work to comply or choose to seek modification of the code(s) through the formal appeals process.

If the construction documents are inadequate, an applicant should make the necessary changes or additions to them.

A properly executed Step 2 (Preliminary Review) should reduce problems in this step to a minimum, and expedite the issuance of the construction permit(s).

With the filing of the construction permit(s), construction may begin.

Rehabilitation

For rehabilitation, the construction permit process is generally the same as that for new construction. There are, however, some aspects of rehabilitation which may be different from new construction, and some aspects of the appoval process which may be improved to better serve rehabilitation:

- *Construction Documents*—In some instances, rehabilitation construction documents may not need to be as extensive or detailed as those required for new construction. It may be possible in some communities for less complex projects to use a written description of materials and equipment as construction documents, and where necessary to supplement this with one-line diagrams, sketches or product literature.
- *Partial Permits*—1In some communities, Partial Permits may not be in common use, or may not be permitted. However, because their use is expecially suited to the rehabilitation of selected parts of an existing building (e.g., electrical system, plumbing system, etc.), the use of Partial Permits should be considered. The higher fee for multiple Partial Permits (as compared to a Full Permit fee) may be a constraint to rehabilitation which communities can modify.
- *Conditional Permits*—In rehabilitation, Conditional Permits are particularly useful to allow that selected demolition necessary for the exploration of concealed construction to determined the condition and adequacy of existing materials, equipment and installation methods as preparation for establishing a rehabilitation scope-of-work (see Step 2. Preliminary Review).
- *Preliminary Review*—The findings from a Preliminary Review may be even more important to rehabilitation than to new building design and construction. These findings should be fully and carefully incorporated into the application for the permit(s) as a means to reduce delays in this step and in the Construction Inspection step following.

Recommendations

- Amend the community's Construction Permit procedures and related fee structures, to utilize Partial Permits and Conditional Permits as needed to accommodate the needs of rehabilitation.
- Establish construction document requirements appropriate to rehabilitation.
- Develop a system which incorporates the conclusions of the Preliminary Review into the Construction Permit processing.

Step 4. *Construction Inspections*

New Buildings

This step in the approval process consists of:

- inspections during construction,
- a final inspection upon the successful completion of construction, and
- in some communities, issuance of a Certificate of Occupancy upon approval of the final inspection.

These are officially carried out by authorities having jurisdiction, which may include not only the building department, but such other departments as fire, health, etc.

With the issuance of a construction permit (Step 3), the authority having jurisdiction usually establishes its inspection schedule. For construction inspections, this may be:

- inspections of specifically identified work items ("call-in" inspections by appointment);
- routine inspections independent of the progress of the work ("drop-in" inspections following the inspector's routine); or
- a combination of the above.

The purpose of construction inspections is to assure the conformance of the work to the approved plans and to specific code requirements. This may simply require the inspector to observe the work in progress. In some instances, measurements are necessary (e.g., spacing of structural members, pipe sizes, etc.), and sometimes tests are required (e.g., strength of concrete, plumbing DWV air and water tightness, etc.).

If any work is found not to comply with the approved plans or the code, it must be corrected to conform.

With an approved final inspection or when a Certificate of Occupancy is issued, the construction documents, permits and inspection reports are made a part of the community's official records.

Rehabilitation

The construction inspection process for rehabilitation projects is the same as that for new building construction. There are some aspects of rehabilitation, however, which require special consideration in this step.

In rehabilitation, unforeseen conditions within existing construction are likely to be encountered. Also, construction documents are likely to be less detailed about existing construction. Both of these aspects of rehabilitation may require more care and effort in construction inspections with regard to:

- determining the conformance of existing construction exposed during the work to applicable code requirements;
- establishing any increases in the scope of new work approved by the

construction permit(s) as a result of non-conforming existing construction;
- changing new work required by the condition of existing construction (e.g., obstruction of a new pipe chase by existing, concealed structural members); and
- carrying out an increased number of performance tests to establish final acceptance of the work (e.g., *Plumbing DWV Guideline for Residential Rehabilitation).*

These unique requirements of rehabilitation may be accommodated if a community implements the following:
- giving inspectors more authority to make decisions in the field,
- establishing procedures to support those field decisions, and
- improving the communication between plan reviewers and inspectors with regard to the scope, terms and conditions of new work approved on the construction permit(s).

Seattle, Washington, for example, has established and uses procedures which give inspectors more latitude to approve construction field changes in rehabilitation. Also, in major rehabilitation projects, Seattle plan reviewers visit the rehabilitation sites in order to expedite the start of projects.

Finally, the unique nature of rehabilitation suggests that special care be given to the recording of construction documents, permits and inspection reports in order to facilitate maintenance inspections and future rehabilitation.

Recommendation

- Institute the necessary practices, including training if required, to accommodate the unique inspection requirements of rehabilitation, such as increased inspector authority, improved communications, specific inspection techniques and performance testing.

Step 5. Maintenance Inspections

New Buildings

Once a building has a Certificate of Occupancy, it becomes subject to maintenance inspections throughout its life. These periodic, formal inspections sometimes may be made by a community's building department, but more often they are made by the fire and health departments or other authorities. These inspections are made to enforce property maintenance codes, fire prevention codes and hazard abatement codes.

If one of these inspections finds a building not to be in compliance with the applicable code, a correction notice may be issued and enforced by the courts. If such non-compliance is found to be an imminent hazard, and the condition is not corrected immediately, applicable enforcement procedures must be followed.

Rehabilitation

While the maintenance inspection of rehabilitated buildings is in almost every respect the same as that for new buildings, there may be special circumstances related to the conditions of approval of a rehabilitation project which require extra consideration in inspections, such as:
- posting of limited live loads (see *Guideline for Setting and Adopting Standards for Building Rehabilitation*),
- egress which generally is unacceptable for the elderly or handicapped (see *Egress Guidelines for Residential Rehabilitation*),
- egress which relies on alarms or sprinklers, or
- posting of a second electrical service entrance and disconnect (see *Electrical Guideline for Residential Rehabilitation*).

Recommendation

- Assure that any records used in the maintenance inspections of rehabilitated buildings adequately reflect all conditions of approval (established in Steps 2, 3 or 4 above) which may be subject to periodic inspection.

EGRESS GUIDELINE FOR RESIDENTIAL REHABILITATION

Table of Contents

I Prologue
Introduction
Basic Fire Protection and Egress Principles
General Assumptions
Arrangement of the Guideline
II Guideline
General Requirements
Smoke Detectors
Height and Area Limitations
Occupant Load
Technical Guideline
1. Number of Exits
2. Horizontal Exits
3. Interior Stairs/Enclosures
4. Exterior Exit Stairs
5. Fire Escape Stairs
6. Arrangement of Exits
7. Travel Distance
8. Dead End Travel
9. Corridors and Exterior Exit Balconies
10. Exit Capacity/Widths
11. Construction Details and Specifications

I Prologue

Introduction

Egress requirements create a great number of technical problems and constraints in building rehabilitation. Existing exits which appear to be adequate will often not comply with the highly specific requirements for new building construction. Adding new exits or upgrading existing ones to meet new construction requirements can require the removal or alteration of otherwise sound structural elements such as walls, floors, hallway partitions, and doors.

The *Egress Guideline for Residential Rehabilitation* is not a code. It is to be used in conjunction with existing building codes, by persons knowledgeable in fire protection and building construction, to aid in interpreting the provisions of those codes for the special needs of rehabilitation. It is intended to facilitate the continued use of existing egress elements in the rehabilitation of buildings whenever feasible.

The guideline applies to one- and two-family dwellings and apartment houses less than 75 feet in height. Dormitories, lodging or boarding houses, and residential hotels that meet the conditions set out under *GENERAL ASSUMPTIONS* below could also be within the scope of this guideline. The goal of the guideline is to facilitate rehabilitation in circumstances where, for some reason, building code requirements for new construction are being applied. In general, there are two such circumstances:
- Repair and improvement of existing residential buildings, when compliance with the code requirements for new construction is triggered by a 25–50% Rule, or similar rule, which is in effect in the jurisdiction.
- Change of use or occupancy into a residential occupany (e.g., from one- and two-family dwelling to apartment house, from office building to apartment house, etc.), when compliance with the code requirements for new construction is triggered by the provisions of the building code in effect, or some other provision.

This guideline applies to "change of use or occupancy" rehabilitation when egress elements are already in place, or where other building elements (structural or non-structural) make literal code compliance impractical. By contrast, for example, this guideline does not apply to a warehouse that will be completely gutted during conversion to an apartment house. Such a conversion can, in most instances, be designed to meet new code requirements for egress without hardship.

This guideline is an endeavor to suggest solutions which will establish an approximately equivalent overall level

of fire safety without attempting to obtain literal code compliance. It is not a criticism of new construction requirements and does not imply that the suggested solutions are equivalent. Where compliance with new construction requirements does not present serious difficulty and is otherwise feasible, this guideline should not be the sole justification for non-compliance.

Communities that would not normally apply a new construction code to a rehabilitation project (e.g., the community has enacted its own building rehabilitation code) may still have use for selected portions of this guideline. There may be instances, though, where the solutions suggested below may be more stringent or restrictive than those already permitted or intended by the community. In such cases, the community must accept the responsibility to devise solutions that respond to unique local needs. The *Guideline for Setting and Adopting Standards for Building Rehabilitation* outlines a procedure to meet this task. Each community must assess its resources and its needs, and then define and set forth the codes, standards or regulations necessary to meet the common good.

Basic Fire Protection and Egress Principles

A safe means of escape from fire is fundamental to fire protection. But total evacuation of a building is not the only way to provide life safety from fire, and it is not always the most efficient: fire officials would need hours to totally evacuate a very tall building. Different building types will often pose different egress problems. Code requirements for egress must be responsive to the qualities and needs of the people to be protected and the hazards that they face.

The differing requirements of the three model building codes (Basic, Standard, Uniform) and the Life Safety Code illustrate that there is no single correct solution. The codes reflect the differences in opinion and philosophy that exist whenever professional judgment must be exercised. The issue is not which approach is most correct, but which is most appropriate once the character of the building and the occupants is known.

Given that a fire ignition has occurred, there are two basic approaches to solving the life safety problem:

- protect the people
- control the fire

The people could either be evacuated from the building or protected in place until the fire is extinguished and the danger passes. The fire can be controlled by suppression (e.g., automatic sprinklers) or compartmentation (e.g., fire resistive construction, protection of horizontal/vertical openings).

Smoke control systems attempt to prevent smoke and other fire gases from spreading throughout a burning building. Exits free of smoke can be used more safely and efficiently; the protection of occupants becomes more feasible because life-threatening combustion products are removed from the building. No specific recommendations have been included in this guideline concerning the use of smoke control systems, but the potential of the rapidly improving technology must be recognized.

In low and mid-rise residential buildings, the simplest and most direct solution is to evacuate the occupants. This may avoid the need to upgrade the fire resistance of major structural elements such as walls, floor/ceiling assemblies, and doors. Such major renovation is counter to the goal of decreasing the cost and complexity of building rehabilitation, particularly when alternatives are usually available.

The evacuation system consists of three interrelated component parts, and the guidelines build upon these relationships. The components are:

- fire detection and alarm;
- a path of escape or means of egress; and
- a safe destination.

In a one-and two-family dwelling "fire detection and alarm" is a smoke detector; the "means of egress" is the front door or escape window; the "safe destination" is the outside or some other protected area of refuge. The concepts are equally applicable to apartment houses, though the problems and requirements are more complex. Fire detection and alarm is more difficult because a single station smoke detector will only warn the occupants in a single unit, not the entire building. Two or more exists, instead of a single exit, are generally required.

The approach taken by the guideline is quite basic: identify the requirements, isolate the deficiencies, and then correct or compensate. To correct the deficiency is to comply with the code; to compensate for the deficiency is to meet its spirit and general intent. Note again the stated goal of this guideline: "an approximately equivalent *overall* level of fire safety."

There is no exact method for determining whether one set of corrective measures exactly equals another. But it is possible, with reason and professional judgment, to define the intent and purpose of code requirements, and then match these needs against the available fire protection techniques and materials. The task is made easier because, as noted above, while there are different approaches to solving life safety problems, these approaches are interrelated. Also, many fire protection measures have more than one impact.

For example, a suppression system can potentially control the fire, provide an emergency alarm to occupants, summon the fire department, and increase the time for safe escape by confining the fire to its compartment of origin and protecting the egress path. Improved lighting or additional handrails might compensate for deficient stairs when the number of occupants is small and the building occupants are physically able. Smoke detectors allow more time for escape while the fire is still in its incipient, least threatening stage and may permit early extinguishment.

The examples cited and the egress guidelines that have been developed are not exhaustive. There is no intent to limit the types of solutions that may be developed or considered effective. The guideline recognizes this, for the problems and solutions which have been included are headed "Selected Problems and Representative Solutions." Each building will present specific problems that will require specific treatment. Once the intent of the code requirement and the impact of the deficiency are understood, it may be possible to fashion an alternative solution. But the most important consideration will always be the character and status of the occupants and the use and arrangement of the building.

General Assumptions

Five assumptions have been made that impact upon the applicability of the Egress Guideline.

The rehabilitated structure must be intended for general residential use and the resident population representative of the population at large, which will likely include some elderly and handicapped persons. However, housing that is *primarily* directed towards elderly or handicapped persons is not within the scope of this guideline. The inability or increased difficulty of these persons to react quickly and properly, without assistance, to an alarm of danger requires an analysis and degree of safety that is beyond the generalized scope of this guideline.

It is assumed, that the occupants are familiar with their surroundings,

particularly the location of exits. This assumption makes the guideline inapplicable to hotels/motels or other occupancies with a transient resident population.

The population density is assumed to be small enough such that there would be no problem of queing at the exits. That is, all residents should be able to move continuously towards the exits without having to wait in line. This can be a problem in dormitories, boarding houses, and group residences. Therefore, the number and capacity of exits in these residential buildings must be given special attention.

Building codes contain a number of highly specific provisions controlling the quality of exits such as exit signage, illumination, emergency lighting, handrails, etc. It is assumed that both existing exits and any new exits that may be called for under this guideline will comply fully with these requirements.

Finally, it is assumed that the building is not deficient in too many areas. The concept of compensating for one deficiency by relying upon, or providing, other positive features becomes either too difficult or too tenuous if there are too many problems. For just as a single fire protection feature can provide several positive benefits, a single deficiency can have several negative impacts, and multiple deficiencies simply compound the problem further.

Arrangement of the Guideline

The various sections of the egress guideline have been placed in a sequence that parallels the procedure normally followed by local enforcing officials. They have been arranged as follows:

The occupant load (see discussion below), the physical characteristics of the building (e.g., height, area) and the use (e.g., apartment) determine the *minimum* number of exits that are required. Section 1 NUMBER OF EXITS addresses this area.

Once the required minimum number of exits is known, the number of available exits is counted. The concern is that the exits be of the proper type and that minimum fire resistive enclosure requirements, if any, are met. For example, some codes place limits on the use or number of horizontal exits. Generally, codes requires stairs to be enclosed by fire resistive construction. Guidelines have not been developed for every acceptable egress component, but Sections 2–5: HORIZONTAL EXITS; INTERIOR STAIRS/ENCLOSURES; EXTERIOR EXIT STAIRS; FIRE ESCAPE STAIRS apply here.

The location and layout of the qualifying exits is then examined. See Section 6: ARRANGEMENT OF EXITS. Improper arrangement may require that additonal exits be provided.

Access to these exits must also be evaluated and corrective measures must be taken as needed. Section 7: TRAVEL DISTANCE; Section 8: DEAD-END TRAVEL; and Section 9: CORRIDORS AND EXTERIOR EXIT BALCONIES should be applied at this time. As above, additional exits may be required if conditions are too severe.

Once the number of required exits has been provided and their arrangement and access is satisfactory, the capacity of the exits and minimum width dimensions must be considered. Section 10: EXIT CAPACITY/WIDTHS applies here.

Finally, the specific construction details of the egress components must be evaluated. See Section 11: CONSTRUCTION DETAILS AND SPECIFICATIONS.

There is a 3-part discussion within each of the eleven (11) Sections. First, there is a summary of code requirements and intent, including a discussion of the respective requirements in the Basic, Standard, and Uniform building codes. The Life Safety Code, published by the National Fire Protection Association, is not a building code, but has been included because it deals primarily with egress and has been used in a regulatory context.* Second, there is a discussion of how to identify conditions in the building to determine whether a problem exists. Third, there is a discussion of selected problems, some representative solutions, and a general narrative relating the two.

References to the applicable sections of the model codes have been included throughout the guideline. The references are as follows:

BOCA—Basic Building Code (1978 Edition)
NFPA—NFPA Life Safety Code (1976 Edition)
SBCC—Standard Building Code (1979 Edition)
UBC—Uniform Building Code (1979 Edition)

II Guideline

General Requirements

Smoke Detectors. Though smoke detectors can not control the growth or spread of fire, the early detection and alarm allows greater time for safe escape and possible control or extinguishment while the fire is still developing. This is particularly important in residential occupancies when all the occupants are asleep. Of course, the detector must be properly installed, located, and maintained.

Therefore, the installation of single station smoke detectors for each sleeping area of every dwelling unit is hereby required in this guideline before allowing any significant deviation from the requirements for new construction.

The model codes referenced in the guideline already require the installation of smoke detectors in every dwelling unit.[2] However, not all local communities have adopted one of the model codes, an earlier edition of a code without the smoke detector requirement may still be in effect, or a community may have deleted the smoke detector requirement.

The net effect of some of the solutions suggested below is to meet the new code requirements, so the requirement for smoke detectors noted above would not apply. Smoke detectors must still be installed if otherwise required by the code. But where the community has chosen not to adopt such a general provision, there is no basis for imposing an additional requirement for smoke detectors if a particular deficiency has been corrected to meet the code. The appropriate sections of the guideline have been noted accordingly.

Height and Area Limitations. Building codes usually limit the allowable height and area of a building as a function of its occupancy and type of construction.

In the case of a change of occupancy (into a residential occupancy), the compliance of a rehabilitated building with the height and area limits of the code for new construction is hereby required before applying the solutions recommended in this guideline. Code permitted allowances for increased height and/or area may still be applied.

Occupant Load

The occupant load is the number of people that can be expected to be present in the building. The occupant load is used to calculate the number of required exits and the capacity or required width of these exits.

The occupant load may not be reduced below a minimum specified in the code, regardless of the number of people expected. However, if the actual occupant load will exceed the minimum

* There are literally thousands of different building codes being enforced throughout the United States. The model building codes were selected only because they are nationally known and have been adopted, either in whole or in part, by many communities.

[2] The Life Safety Codes does not require smoke detectors in dormitories and only "on each floor level" of lodging houses. (11–5.3.2.1)

specified in the code, the actual occupant loading is used.

Though each code specifies how the occupant load is to be calculated, the general method is to divide the total gross area by a minimum design density of 200 sq. ft. per person. The only exception is 300 sq. ft. per person in one- and two-family dwellings and 50 sq. ft. per person in dormitories under the Uniform Building Code. The occupant load for each floor is also computed though the method may vary somewhat. (BOCA: 606.0; UBC: 3301(d), Table 33–A; SBCC: 1105.1; NFPA: 5–3.1, 11–1.5).

Given the low population density of most residential use buildings, occupant loading will rarely present a problem. The minimum dimension requirements are more often the source of difficulty. As a general rule, providing the minimum of two (2) exits will be adequate. In residential rehabilitation, it is usually the arrangement and quality of the exits, not the number of building occupants, that will be controlling.

Technical Guideline

1. *Number of Exits*

Summary of Code Requirements and Intent

The codes specify the minimum number of exits that must be provided. The exits must be adequate for each floor as well as for the building as a whole. Other considerations such as travel distance, remoteness, or capacity of existing exits may require additional exits to be provided. These issues are discussed separately and, therefore, are not considered here.

Code Intent. Requirements for a minimum number of exits are established to increase the reliability of the means of egress system. The intent is that for any single fire ignition that prohibits travel to one exit, there will be an alternate exit that can be used. This does not address multiple fire ignitions, as may be likely with fires that are incendiary (intentionally set).

Having a minimum of two means of egress is one of the most fundamental principles of life safety from fire. The codes do allow certain residential configurations to have only a single exit, but every one of these special cases must also comply with the separate, general requirement for operable windows of specified minimum dimensions. These windows allows for escape, provide a source of fresh air if it is necessary to await rescue, and allow for rescue of building occupants by fire service personnel. Therefore, even these buildings could be considered to have two means of escape. All rehabilitated buildings should have escape windows whenever feasible.

Code Analysis

Basic Building Code—1978

Not less than two exitways serving every story, except in one-and two-family dwellings, with the following exceptions where one exitway is accepted (609.2, 609.3):

- on the first story of buildings 2,000 sq. ft. or less with an occupancy load less than 50 on the first story;
- residential multi-family buildings, two stories or less, with four or less dwelling units per floor, maximum exitway access travel of 50 ft., minimum one hour fire resistance rating of exitway enclosure, and minimum one hour opening protection.

The 1980 Supplement added to Section 609.2 the requirement that a minimum of three exits are needed if the occupant load is between 501 and 1,000 persons, and a minimum of four exits must be provided for occupant loads in excess of 1,000.

Uniform Building Code—1979

Every building or usable portion thereof must have at least one exit, except if there are over ten occupants, there must be two exits. Floors above the first story having an occupant load of more than ten shall have not less than two exits, subject to the following two exceptions:

- unless the number of occupants exceeds ten; only one exit shall be required from a second floor area within an individual dwelling unit;
- two or more dwelling units on the second floor may have access to only one common exit when the total occupant load does not exceed ten.

The latter requirement for two exits is applied to individual dwelling units as well: a single apartment unit larger than 2,000 sq. ft. (10 occupants × 200 sq. ft. per occupant) would require two exits from the private unit onto the public exitway; a similar requirement applies to an individual unit of a one- and two-family dwelling larger than 3,000 sq. ft. (10 occupants × 300 sq. ft. per occupant), even if it were a one story building.

Floors above the second story and basements, regardless of the occupant loading, require not less than two exits except when used exclusively for the service of the building; only one exit shall be required from a basement within an individual dwelling unit. As noted above, individual units and basements with an occupant load greater than ten must have two exits as well. Every story or portion thereof having an occupant load of 501 to 1000 shall have not less than three exits; four exits are required when the occupant loads exceeds 1000. (3302(a), Table 33–A, A–1215(b,d)).

Standard Building Code—1979

Not less than two independent exits except for one- and two-family dwellings and other exceptions noted below.

Minimum number of exits:	*Occupant load*
2	50 to 500.
3	501 to 1000.
4	More than 1000.

Residential occupancies having not more than four dwelling units per floor, less than 3500 sq. ft. per floor, and less than three stories in height may be served by one common exit. The travel distance from the entrance door of any living unit to the single exit cannot exceed 30 ft. (1103.2).

NFPA Life Safety Code—1976

Two separate exits are required with the following exceptions:

- one- and two-family dwellings;
- a unit with direct exit to the street at ground level, by an outside stairway, or by a one-hour rate enclosed stair serving only that apartment;
- any height building with four or less units per floor with direct access to a smoke proof tower or outside stair (20 ft. maximum travel distance);
- building three stories or less with one-hour exit and protected openings, corridors with one-hour rating, 20 ft. maximum travel distance (11–3.2.4).

Summary. A minimum of two exits is generally required, although some residential occupancies can have only one if certain requirements are met. The codes are not consistent as to when only one exit will be allowed.

Identifying Existing Conditions

Determine the required number of exits by considering (depending on the particular code in force):

- occupancy (one- and two-family vs. apartment house);
- area (for computation of occupant load);
- number of dwelling units;
- number of stories;
- arrangement of spaces (service rooms, two story dwelling units, etc.).

Determine the number of apparent exits for each floor in the proposed building, by counting the number of separate paths that discharge to a public way or protected area of refuge. The exits, or exit elements, either alone or in combination, are:

- interior stairway;
- exterior stairway;

- horizontal exit;
- smoke proof tower;
- fire escape;
- ramp;
- exit passageway;
- lobby or vestibule;
- exterior exit door.

The number of exits from any story is "apparent" because an element may be determined not to be an acceptable exit element because of violation of some other code provisions addressed later in the guideline.

Particularly in larger buildings, several required stairways and passageways may combine to discharge through a single exit passageway, lobby or vestibule. The codes impose limits upon exits that may combine at a later point, and care must be taken that this limit is not violated.

Selected Problems and Representative Solutions

1.1 *Problem:* Less exits are available than required.

Solution: Consider the use of means of escape, such as fire escapes (see Section 5 below), ladders, fire balconies, etc., which are not normally accepted by codes as exit elements for new construction, in order to provide the required number of exits. At least one exit should be a means of egress in substantial compliance with code requirements. This exit should preferably follow the path normally used by the building occupants. In an emergency situation, it is common for people to exit the same way they entered and to travel the path most familiar.[3]

Discussion: In accepting this solution, an analysis should be made which takes into account the public acceptability (e.g., would tenants share a common balcony or accept unlocked doors to create an area of refuge), the climate (e.g., accumulations of snow or ice), the ability of fire service personnél to effect rescue or gain access to the building to fight the fire, and the degree of mobility or agility necessary for safe escape.

1.2 *Problem:* One exit available in a building with three occupiable floors when two exits are required.

Solution: A single exit could be accepted if each floor arrangement meets the special conditions for a single exit for two story buildings (e.g., number of occupants or dwelling units, distance of exitway access travel), the stairway is well designed (dimensions as required by code, handrails, illumination, etc.), and the requirement for operable windows is met. The exitway must either be enclosed with construction having a minimum one (1) hour fire resistance or the apartments must be separated from the exit with construction having a similar rating. Existing wood lath and plaster in good condition may remain. Doors to the exit enclosure or apartment doors opening directly onto stairs must have a minimum one hour fire resistance. Existing doors, if substantial (e.g., minimum 1¾" bonded solid core door), may remain if provided with self-closing devices. Lesser doors must be protected on both sides by automatic sprinkler protection. These sprinklers may be connected to the domestic water supply and need not be equipped to sound a building alarm.

Discussion: A single exit is allowed by code for the specified arrangements up to two stories because the building is low, an escape window is required, the distance limitation on exit access, the requirement for compartmentation or exit enclosure, and the limited number of occupants. The requirement for smoke detectors and a high quality exit, coupled with escape windows, the limited number of occupants, and compartmentation, is the basis for extending the exception for a single exit to include buildings with three occupiable floors.

1.3 *Problem:* One exit available in a building over three stories.

Solution: A code complying smokeproof tower or exterior stair could be accepted as the single exit. The building must comply with the height and area requirements for new construction. The arrangement of each floor must meet the special conditions for a single exit for two story buildings and the stairway must be well designed and protected against the elements. Access to the exterior stair or smokeproof tower must either be open to the outside or by a protected corridor. Doors opening onto an enclosed corridor must be substantial (e.g., minimum 1¾" bonded solid core door) and provided with self-closing devices. Lesser doors must be protected on both sides by automatic sprinkler protection. These sprinklers may be connected to the domestic water supply and need not be equipped to sound a building alarm. Doors to a smokeproof tower must comply with the code.

Discussion: The Life Safety Code accepts a smokeproof tower or exterior stair as the sole exit for any height building with four or less units per floor with direct access to the exit (20 ft. maximum travel distance). It is also the traditional design method in Europe and much of the world. The added requirements for smoke detectors, compliance with height and area requirements, and an open air exit access or protected corridor increases the reliability of the single exit. The ability of the fire service to effect rescue or gain access to the building to fight the fire must also be considered.

2. *Horizontal Exits*

Summary of Code Requirements and Intent

Code Intent. The code intent is to provide an area of refuge within a building by providing a continuous barrier that will resist the passage of heat, smoke, and other fire gases. A horizontal exit is a passage from one building area to another. The areas must be separated by fire resistant construction with the appropriate opening protection (self-closing or automatic closing fire doors).

A horizontal exit does not have to be limited to one building, and can be a bridge or protected passageway from one building to another.

Code Analysis and Summary. A horizontal exit is a way of passage from a building to a protected area of refuge, on approximately the same level, within the same or another building. The area of refuge must afford safety from fire and smoke.

Walls or partitions forming the separation through which the horizontal exits provide passage must provide two hours fire resistance. Opening protection (e.g., fire doors, fire dampers) must have 1½ hours fire resistance. Fire doors in horizontal exits must be either self-closing or automatically close upon activation of an associated smoke detector, except that only automatic doors are allowed under the Uniform Code.[4] Doors must swing in the direction of exit travel, except that the occupant load must be fifty (50) or more under the Uniform and Standard Codes before this requirement is imposed.

The Standard and Life Safety Codes provide that horizontal exits cannot comprise more than one-half the required exits. The Uniform, Standard and Life Safety Codes require that the area of refuge into which the horizontal exit leads have an enclosed stair, door or other "standard" exit that leads directly to the exterior. The Basic Code requires one interior stairway or smokeproof enclosure on each side of the horizontal exit in multi-story buildings.

The area of refuge must be of sufficient area to be occupied by the

[3] This does not mean that elevators should be accepted as a means of escape. In such a case, it is the exit that most closely follows the normal path of entrance.

[4] A current change to the Basic Code only accepts automatic closing doors.

total occupant load of the connected areas based upon three sq. ft. per person (net). The codes contain various other prescriptive requirements relating to dimensions, materials and hardware. (BOCA: 614.0, and reported code amendment; UBC: 3307, 3303(b); SBCC: 1119; NFPA: 5–2.4)

Identifying Existing Conditions

Determine the fire resistance of the wall or partition assembly and protection of openings by reference to the code in effect, current or past listings, labels, or the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

Selected Problems and Representative Solutions

2.1 *Problem:* The fire resistance of the wall or partition, as determined above, is below that required by code.

Solution: Upgrade the wall or partition construction to meet code requirements.

Discussion: The fire resistance of the wall or partition should be improved by repairing the existing construction or adding a new layer(s) of fire resistive materials. See the *Guideline on Fire Ratings of Archaic Materials and Assemblies.* If the fire resistance is upgraded to code requirements, single station smoke detectors need not be installed, unless otherwise locally required.

Solution: Accept a wall or partition of one hour fire resistance. Doors must provide one hour fire resistance and close automatically upon activation of a smoke detector. The wall or partition should be carefully inspected to insure all penetrations, particularly ducts or other utility services, are properly protected and the existing materials are intact and structurally sound.[5]

Discussion: The single station smoke detector will provide added time for escape. Also, the expected severity of fires in residential occupancies should be contained by one hour fire resistive construction.

2.2 *Problem:* Fire resistance of the opening protection, as determined above, is below that required by code.

Solution: One hour doors may be accepted if protected on both sides by automatic sprinkler protection. These sprinklers may be connected to the domestic water supply and need not be equipped to sound a building alarm. Otherwise, the door must be upgraded to meet the code requirements or replaced.

[5] The area of refuge to which the horizontal exit leads must have either a complying exit stair or exterior exit door.

Discussion: The water spray from the local sprinkler will compensate for the reduced fire resistance.

2.3 *Problem:* The only exit from an area of refuge is another horizontal exit, in violation of the code.

Solution: Accept such an arrangement (i.e., *one* intermediate compartment) if the fire resistance of all walls or partitions separating the compartments, and the protection of all openings in the walls or partitions, fully comply with the code requirements.

The area of refuge reached after passing through the intermediate compartment must have a complying stair or exterior exit door.

3. Interior Stairs/Enclosures

Summary of Code Requirements and Intent

Enclosed stairs are recognized as an exit by all codes if they are properly designed and constructed. In multi-story buildings they are the most likely type of exit to be encountered. They provide a protected means for evacuation of a building by its occupants. By their nature as vertical shaft through a building, stairs also provide a potential path for the spread of fire from floor to floor.

Code Intent. Requirements for a fire resistive enclosure of stairs are established in order to achieve the following objectives:

- to provide a protected way from any story of a building to a public way or to an area of refuge;
- to limit the spread of fire from floor to floor;
- to provide a protected access for fire service personnel.

Code Analysis

Basic Building Code—1978

Required interior exitway stairs must have an enclosure of 1-hour fire resistance rating in buildings three stories or less, 2-hour fire resistance rating in buildings four stories or more. Stairs within a single dwelling unit are excepted. Also excepted, when automatic sprinkler protection is provided, are stairs between no more than three communicating floors close to street level which serve no more than one-half the required occupant load and which have adequate capacity for all occupants of all the communicating levels.

Stairway doors must be self-closing and have a 1-hour fire resistance rating in 1-hour construction and 1½ hour rating in 2-hour construction. Labeled fire doors shall have a maximum transmitted temperature end point of not more than 450°F above ambient at the end of 30 minutes of standard fire test exposure. Other openings are limited in area and must be protected. (616.6.3, 616.9.2, Table 214)

Uniform Building Code—1979

For new construction, interior stairways are required to be enclosed, with the following exception: stairways in one- and two-family dwellings, and stairs within individual apartments need not be enclosed. Enclosure walls must be a minimum of two-hour fire resistive construction in buildings more than four stories in height and not less than one-hour fire resistive construction elsewhere. All exit doors in an exit enclosure must be protected by a fire assemble having a fire resistance of not less than one hour where one-hour shaft construction is permitted and one and one-half hours where two-hour shaft construction is required. Doors must be maintained self-closing or automatic closing by actuation of a smoke detector. The maximum transmitted temperature end point shall not exceed 450°F above ambient at the end of 30 minutes of fire exposure. (3308(a)–(c), 4306(b))

Appendix Chapter 12 is a retroactive provision that establishes minimum requirements for all existing apartment buildings and hotels more than two stories in height. Because all such buildings would be required to comply with these minimim safety regulations, Section 103 of the Uniform Code provides that a community must specifically adopt the Appendix for its provisions to apply.

Appendix Chapter 12 sets forth the following requirements. Every interior stairway must be enclosed with walls of at least 1-hour fire resistive construction. Wood lath and plaster in good condition is acceptable as 1-hour construction for this purpose. The stairway need not be enclosed in a continuous shaft, but the continuity of the enclosure on each floor is required. Enclosurers are not required if an automatic sprinkler system is provided in all portions of the building except apartments. Stairway doors must be self-closing and equivalent to a solid wood door not less than 1¾ inches thick. (A–1215(f))

Standard Building Code—1979

Required exit stairs must be enclosed in 1-hour fire resistive construction in buildings three or less stories in height; 2-hour fire resistive construction in buildings four or more stories in height. Exceptions are similar to those noted above for the Basic Building Code. (1106)

Stair doors must be 1½ hour fire resistive assemblies for 2-hour walls, and 1-hour fire resistive assemblies for 1-hour walls. The maximum transmitted temperature end point shall not exceed 450°F above ambient after 30 minutes of standard fire test exposure.

NFPA Life Safety Code—1976

Stairways must be protected as follows:

Fire resistance of walls in buildings of one-three stories shall be 1-hour; four or more stories, 2-hours. Fire resistance of doors in buildings of one-three stories shall be ¾ hour; four or more stories shall be 1-½ hours. In buildings provided with total automatic sprinkler protection, the fire resistance of walls in buildings of one-three stories may be reduced to ¾ hours; four or more stories, 1-hour. The fire resistance of doors in sprinklered buildings of any height shall be ¾ hour. (11–3.5.3.1.1, 11–3.8.3.1.1)

Exceptions, including the exception allowing unenclosed stairs as part of communicating floors, are similar to those noted above for the Basic Building Code. (6–1)

Summary. The Basic, Standard, and NFPA Life Safety Code generally have identical provisions (2-hours with 1-½ hour door over three stories; 1-hour enclosure and door below four stories), except that NFPA requires only a ¾ hour door in a 1-hour stair enclosure. The Uniform Code differs in that buildings up to four, rather than three, stories only need a 1-hour enclosure. The Uniform Code Appendix Chapter 12 contains much more lenient requirements for existing residential buildings.

Identifying Existing Conditions

- Determine location of all unenclosed stairs.
- Determine the fire resistance of stair enclosures and doors by reference to the code in effect, current listings, or the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

Selected Problems and Representative Solutions

3.1 *Problem:* The fire resistance of the stair enclosure, as determined above, is below that required by the code in effect.

Solution: The fire resistance of the stair enclosure should be improved by repairing the existing construction or adding a new layer(s) of fire resistant materials. See the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

Discussion: If the fire resistance is upgraded to code requirement, single station smoke detectors need not be installed, unless otherwise locally required.

3.2 *Problem:* A 2-hour enclosure is required and an unenclosed stair does not meet the applicable code exception for communicating floors.

Solution: The stair may be enclosed at each story by construction having 1-hour fire resistance. The walls forming this enclosure may be located on each story wherever convenient, but as close as possible to the stair. Walls should extend through any concealed or void spaces to the underside of the floor above. Any area or section of a floor/ceiling assembly necessary to form a continuous enclosure from story to story must also have 1-hour fire resistance rating.

If necessary, a limited number of apartment doors may open directly onto the stair enclosure. These doors must provide one hour fire resistance, be selfclosing, and meet all other code requirements for stairway doors.

Discussion: The proposed solution provides a protected way of escape from any story while limiting the potential of fire spreading from floor to floor. The population density is low and the fire loading is not excessive. Single station smoke detectors will allow more time for escape.

3.3 *Problem:* A 1-hour enclosure is required, and an unenclosed stair does not meet the applicable code exceptions for communicating floors.

Solution: The stair may be enclosed at each story by construction having a fire resistance of 45 minutes (e.g., ½" type X gypsum wallboard). Up to 25% of the wall area on any given floor may be fire-rated wire glass in a steel frame. Substantial doors (e.g. minimum 1-¾" solid bonded core door) may be used if provided with self-closing devices.

Discussion: Reducing the required fire resistance from one hour to 45 minutes should still allow adequate time for safe escape given the smoke detectors and low occupant loading. The use of wired glass is often least objectionable from architectural and security considerations.

3.4 *Problem:* A 1-hour enclosure is required, and the stairway is enclosed with wood lath and plaster construction.

Solution: Accept the existing enclosure if it is in good condition and all penetrations and openings are either sealed or properly protected. A visual check should be made to insure the quality of the existing construction. There should be no other serious code deficiencies in the building.

Discussion: The presence of smoke detectors, the absence of any other serious code deficiencies, and the limited occupant loading make it reasonable to allow the existing enclosure to remain.

4. *Exterior Exit Stairs*

Summary of Code Requirements and Intent

Code Intent. The code intent for exterior stairs is the same as for interior stairs. However, because the stairs are outside the building, they do not create a vertical shaft through which the fire could spread. An important consideration, though, is the proximity of an exterior stair to openings in the exterior walls: a fire inside of the building could break out windows or other openings and cause the stair to become impassable.

A visual enclosure is sometimes required for exterior or outside stairs so that acrophobia (fear of heights) will not impede travel or lead to panic.

Code Analysis

Basic Building Code—1978

Exterior stairs may be used: (1) in buildings not exceeding five stories or 65 feet in height; and (2) where at least one door from each tenant opens onto a roofed-over open porch or balcony served by at least two stairways. Only one stairway is required if the code only requires a single exit. In buildings three or more stories in height, openings below and within 10 feet horizontally of the exterior stairs must be protected by automatic doors and windows of ¾ hour fire resistance. Exterior stairs must conform to the requirements for interior stairs in all other respects. (619.0)

Uniform Building Code—1979

For new construction, exterior stairs must meet the requirements for inside stairs except for opening protection. In buildings three or more stories in height, openings below or within 10 feet measured horizontally must be protected by a self-closing fire assembly having ¾ hour fire resistance except that openings may be unprotected when two separated exterior stairways serve an exterior exit balcony.

In existing buildings, (Appendix Chapter 12) the *only* requirements are that exterior stairs must be noncombustible or of wood of not less than 2-inch nominal thickness with solid treads and risers. (3305, 3305(1); Appendix Chapter 12, 1215(g)).

Standard Building Code—1979

Exterior stairs may be used: (1) in buildings not exceeding six stories or 75 feet in height; and (2) where at least one door from each tenant opens onto a roofed-over open porch or balcony

served by at least two stairways so located as to provide a choice of independent means of egress leading directly to grade. Openings below and within 10 feet horizontally of the exterior stair must be protected with ¾ hour fire resistive automatic opening protectives; opening protection is not required for buildings not more than three stories in height where all parts of the exterior stair are at least 6 feet from the building wall. Exterior stairs must conform to the requirements for interior stairs in all other respects. (1129)

NFPA Life Safety Code—1976

Where interior stairs are required to be enclosed, exterior stairs must be separated from the interior of the building by fire resistive walls as required for interior stair enclosures; fire doors or fixed wire glass windows must protect any openings therein. Such protection is not required in buildings three stories or less in height where there is a remote second exit. Other openings within specified distances must be protected. A "visual" enclosure must be provided for the benefit of persons afraid of heights. Exterior stairs must conform to the requirements of interior stairs in all other respects. (5–2.5)

Summary. The codes differ as to both when an exterior stair may be allowed and the need for protection of openings. The Basic and Standard Codes only permit exterior stairs in pairs. The Uniform Code does not require exterior stairs in pairs, but waives the requirement for opening protection if the second stair is provided. The Uniform Code, Appendix Chapter 12 for existing buildings, does not require protection of openings for a single exterior stair. Only the Life Safety Code requires a "visual" enclosure for the benefit of persons afraid of heights.

Identifying Existing Conditions

- Determine the fire resistance of walls or opening protectives within or adjacent to the exterior stairs by reference to labels, the code in effect, current listings, or the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

4.1 *Problem:* Fire resistance of the opening protection, as determined above, is below that required by the code in effect.

Solution: The openings need not be protected if there are a minimum of two exterior stairs located as to provide remote means of egress from an exterior exit balcony.

Discussion: This solution is recognized by the Uniform Code. It is unlikely that a fire would block the access to or the use of both exterior stairs. The requirement for single stations smoke detectors is added justification.

4.2 *Problem:* Fire resistance of the opening protection, as determined above, is below that required, and there is only a single exterior stair.

Solution: Upgrade the fire resistance of the opening protection by repairing the existing construction or adding a new layer(s) of the fire rated materials. See the *Guideline on Fire Ratings of Archaic Materials and Assemblies.* Windows must be wire glass in steel frames, either fixed or automatically closing, sealed, or otherwise made to comply with the code.

Discussion: If the fire resistance is upgraded to code requirements, single station smoke detectors need not be installed, unless otherwise locally required.

Solution: Install local sprinklers over opening protection. Such sprinklers may be connected to the domestic water supply and need not sound an alarm upon activation. Windows must be protected as above.

Discussion: The water spray on the exposed surface will compensate for the reduced fire resistance. The sprinklers should be located on the inside of the opening.

5. Fire Escape Stairs

Summary of Code Requirements and Intent

Code Intent. The code intent is to regulate the qualify of the required means of escape. Fire escapes are not favored because they are more difficult to traverse and afford less protection to occupants than other types of exists, such as enclosed interior stairs or exit passageways. However, properly designed and protected fire escapes can sometimes provide a practical solution when the existing number of exists or exit capacity is less than required.

Code Analysis

Basic Building Code—1978

Fire escapes are permitted only on existing buildings, and then only when "more adequate exitway facilities cannot be provided". Fire escapes cannot provide more than 50% of the required exit capacity. Doors and windows "along the fire escape" must be protected with 3/4 hour fire resistance rated opening protectives. (621.0).

Uniform Building Code—1979

Fire escapes are not allowed for new construction. Appendix Chapter 12 permits fire escapes to be used as one means of egress in existing buildings. Under specified conditions a "ladder device" may be used "in lieu of a fire escape". There are no requirements for protection of adjacent openings. (Appendix Chapter 12, 1215(h))

Standard Building Code—1979

If "more adequate exit facilities cannot be provided", fire escapes can be used on existing buildings four stories or less in height. Fire escapes cannot provide more than 50% of the required exit capacity. All openings within 10 feet of fire escapes must be protected with approved opening protectives of at least 3/4 hour fire resistance. (1116)

NFPA Life Safety Code—1976

Fire escape stairs may be used only in existing buildings, but shall not constitute more than 50% of the required exit capacity. Openings within specified limits "shall be completely protected by approved fire doors or metal-frame wire glass windows". (5–2.9)

Summary. Fire escapes are not accepted as a means of egress for new construction. The Basic, Standard, and Life Safety Code permit fire escapes in existing buildings, but only up to 50% of the required exit capacity. Appendix Chapter 12 of the Uniform Code, when adopted, allows a fire escape as "one means of egress" in "existing nonconforming . . . (apartments) more than two stories in height". All codes except Appendix Chapter 12 require adjacent openings to be protected, though the provisions are not consistent and there are exceptions. The codes all contain other higherly specific construction specifications.

Identifying Existing Conditions

- Determine that soundness and structural serviceability is as required by code.
- Determine that access to fire escape(s) is as required by code.
- Determine the fire resistance of the protection of openings by reference to labels, the code in effect, current listings, or the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

Selected Problems of and Representative Solutions

5.1 *Problem:* Fire resistance of the opening protection, as determined above, is below that required.

Solution: Upgrade the fire resistance of the opening protection by repairing the existing construction or adding a new layer(s) of the fire rated materials. See the *Guideline on Fire Ratings of Archaic Materials and Assemblies.* Windows must be wire glass in steel

frames, sealed, or otherwise made to comply with the code.

Solution: Install local sprinklers over opening protection. Such sprinklers may be connected to the domestic water supply and need not sound an alarm upon activation. Windows must be protected as above.

Discussion: The water spray on the exposed surface will compensate for the reduced fire resistance rating. The sprinklers should be located on the inside of the opening.

6. Arrangement of Exits

Summary of Code Requirements and Intent

Code Intent. The intent of providing exit remoteness, when two or more exits are required, is to minimize the probability that access to the exits will be blocked by any one fire. The term "remote" is subjective and frequently a matter of interpretation.

Exits which appear to be remote from each other sometimes converge at a distant point. Stairways discharging into a common lobby or passageway are examples. These exits are not truly remote because a blockage at the point of confluence renders both exits useless.

Code Analysis and Summary. Exits must be located so that they are discernible and have unobstructed access. They also must be arranged to lead directly to the street. When more than one exit is requiired, exits muist be as remote from each other as practicable, and must be arranged to allow direct access in separate directions. Exits shall be arranged and constructed as to minimize any possibility that both may be blocked by any one fire or other emergency condition. (BOCA: 602.2, 602.3; SBCC: 1103.1; NFPA: 5–5)

The Uniform Building Code has a prescriptive technique for determining exit remoteness. If two exits are required, they shall be placed a distance apart equal to not less than one half the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between exits. An exception is made for exit enclosures interconnected by an approved corridor. Where three or more exits are required, they must be arranged a reasonable distance apart so that if one becomes blocked the others will be available. (UBC: 3302(c))

Identifying Existing Conditions

The arrangement of the acceptable exit components will be noted on the building plans or may be studied by a visual inspection of the physical structure.

Selected Problems and Representative Solutions

6.1 *Problem:* Required exits not remote from one another.

Solution: Separate the non-remote exits by smoke barriers located as to establish distinct and separate smoke zones.

Discussion: With certain building configurations it is possible to isolate non-remote exists from one another. By constructing smoke barrier partitions, the requirement of direct access to the exits in separate directions can be met. Figure 1 illustrates this concept. No matter where the fire may originate, any occupant can safely pass from one zone into another. This approach would not work for the building in Figure 2 because these exists, though now in separate zones, cannot be reached by moving in separate directions: a fire blocking one exit would block the second.

ACCEPTABLE

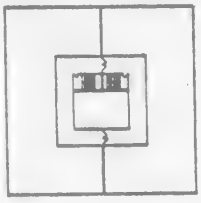


FIGURE 1

NOT ACCEPTABLE

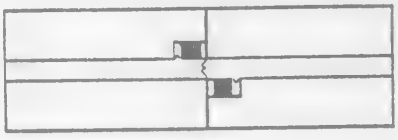


FIGURE 2

The smoke partitions could be constructed of wire glass, gypsum or other suitable materials. Construction similar to the existing corridor walls is also acceptable. The barriers must extend from exterior wall to exterior wall and from the floor to the underside of the floor or roof above, through any concealed or void spaces. Existing walls and partitions can be used to help form this continuous barrier.

The doors need not swing in the direction of exit travel, but double-acting doors are not acceptable. Doors shall close automatically upon the activation of an associated smoke detector. Doors, when closed, must fit tightly and prevent the passage of smoke. Minimum corridor or hallway dimensions should be observed as closely as possible. See Section 7: TRAVEL DISTANCE, if travel distance limitations are exceeded.

Solution: Provide additional exit(s) (e.g., stair, fire escape, fire balcony).

Discussion: If separation of the exits as discussed above is not possible, then additional exits must be provided so that all occupants will have remote access to the required number of exits. The quality of the additional exits (e.g., enclosed stair v. ladder) will depend upon the use and occupancy of the building. If a high quality remote exit is provided (e.g., enclosed stair), single station smoke detectors need not be provided, unless otherwise locally required.

7. Travel Distance

Summary of Code Requirements and Intent

The codes specify maximum travel distance to the nearest exit.

Code Intent. The intent of requirements governing the maximum travel distance to an exit is to limit the time an occupant needs to reach an exit. When combined with the requirements for a minimum number of exits and for exit remoteness, the limitation on travel distance is intended to assure that even if one exit is blocked by the fire, any occupant will still be able to reach a location of refuge before the fire has spread in a manner as to prevent it. The actual time for escape implied by the maximum travel distance limitation is not explicitly stated.

Code Analysis

Basic Building Code—1978

Length of "exitway access travel" to "an approved exitway" (defined as "that portion of a means of egress which is separated from all other spaces of a building by construction or equipment as required in this code to provide a protected way of travel to the exitway discharge") is as follows:

Without Fire Suppression System..... 100 feet
With Fire Suppression System..... 150 feet

If the travel distance within a living unit is less than 50 feet, or 100 feet if sprinklered, the distance of travel is measured from the "exitway access entrance to the nearest exitway" (i.e., from the apartment door). (607.4)

Uniform Building Code—1979

Maximum distance of travel "from any point to an exterior exit door, horizontal exit, exit passageway or an enclosed stairway" is as follows:

Without Automatic Sprinklers..... 150 feet
With Automatic Sprinklers..... 200 feet

These distances may be increased 100 feet when the last 150 feet is within a corridor that meet specific requirements as to width, height, obstructions, dead ends and openings. (3302(d))

Standard Building Code—1979

Maximum travel distance from any point to the "Nearest exit" (defined as "that portion of a means of egress which is separated from the area of the building from which escape is to be made, by walls, floors, doors or other means which provide the protected path . . . to the exterior") is as follows:

Unsprinklered..... 150 feet
Sprinklered..... 200 feet

If the travel distance within a living unit is less than 50 feet, the distance of travel to an exit is measured from the corridor entrance. (1103.1)

NFPA Life Safety Code—1976

The following are the requirements for travel distance (11–3.5, 11–3.6, 11–3.7, 11–3.8):

	To the nearest exit from an apartment entrance door (feet)	To a corridor door from any room door (feet)
No sprinklers or detection	100	50
Automatic dectectors	150	75
Partial sprinkler protection	150	50
Total sprinkler protection	150	100

"Exit" is defined similarly to "exitway" in the Basic Code.

Summary. The codes have varying dimensional requirements for travel distance. All allow an increase in exit travel distance if there are automatic sprinklers. Only the Life Safety Code allows an increase with automatic detection. The Uniform Code differs from the other codes by specifying the four egress elements to which the travel distance is to be measured.

Identifying Existing Conditions

Determine the distance from the most remote point on every story of the building or from the most remote apartment entrance door (depending on the local code in effect) to the nearest acceptable exit element. Measure the distance along the most direct natural path of travel.

Selected Problems And Representative Solutions

7.1 *Problem:* Measured travel distance exceeds maximum travel distance specified in applicable code.

Six alternative solutions to this problem are suggested below. Some of these solutions may be combined to get an additional increase in the allowable travel distance. A table showing the suggested cumulative increases for the different combinations follows the individual solutions. The maximum cumulative increase should not exceed 125 feet.

Smoke Barrier

Solution: The allowable travel distance may be increased by up to 75 feet if the path is divided by a smoke barrier with smoke actuated automatic closing door. The separation of non-remote exits (Section C: ARRANGEMENT OF EXITS) is a special application of this approach.

The smoke barrier could be constructed of wire glass, gypsum or other suitable materials. The barrier must extend from exterior wall to exterior wall and from the floor to the underside of the floor or roof above, through any concealed or void spaces. The doors need not swing in the direction of exit travel, but double-acting doors are not acceptable. Doors, when closed, must fit tightly and prevent the passage of smoke. Minimum corridor or hallway dimensions should be observed as closely as possible.

Discussion: The added compartmentation offered by the smoke barrier reduces the chance that the entire travel path would be blocked by smoke after a given period of time, thereby compensating for the added escape time due to a longer travel distance. The single station smoke detectors will also provide added time for escape.

Automatic Alarm/Heat Detector

Solution: The allowable travel distance may be increased by up to 50 feet if the building is equipped with an automatic fire alarm system activated by heat detectors located inside every apartment within 6 feet of the corridor door. The alarm should notify all building occupants. Entrance doors to apartments should be equipped with door closers.

Discussion: While the single station smoke detector will notify the occupants of an apartment, other building residents would not be made aware of the emergency. Interconnection of the individual smoke detectors, which are still required, is not realistic because of the large number of false alarms that may be expected. Heat detectors are less sensitive to the environmental causes of false alarms (e.g., burnt toast), but are still capable of providing an alarm before a fire could develop beyond the apartment of origin.

Manual Alarm

Solution: The allowable travel distance may be increased by up to 50 feet if a manual alarm system, not otherise required by code, capable of notifying all the building occupants, is installed. Entrance doors to apartments should be equipped with door closets.

Discussion: The smoke detector within the apartment will allow the occupant to escape while the fire is still small. The other building residents could then be warned by the sounding of the manual alarm.

Automatic Sprinkler/No Alarm

Solution: The allowable travel distance may be increased by up to 50 feet if an automatic sprinkler system is installed in the corridor and an additional sprinkler head is located to protect the apartment side of corridor doors. Such sprinklers need not sound an alarm upon activation. Doors must be provided with selfclosing devices. Single station smoke detectors are still required.

Discussion: The automatic sprinklers and door closers should contain a fire within the apartment of origin and keep the corridor passable.

Automatic Sprinkler/Automatic Alarm

Solution: If the partial sprinkler system discussed above is equipped to sound an alarm to all building occupants, the allowable travel distance may be increased by up to 100 feet. Door closers are still required.

Discussion: The sprinkler head inside each apartment door will perform a function similar to the heat detector in the automatic alarm solution by notifying other building occupants of a fire. The sprinkler system will help contain the fire within the apartment of origin and keep the corridor passable. Single station smoke detectors are still required to warn the occupants within the apartment of origin.

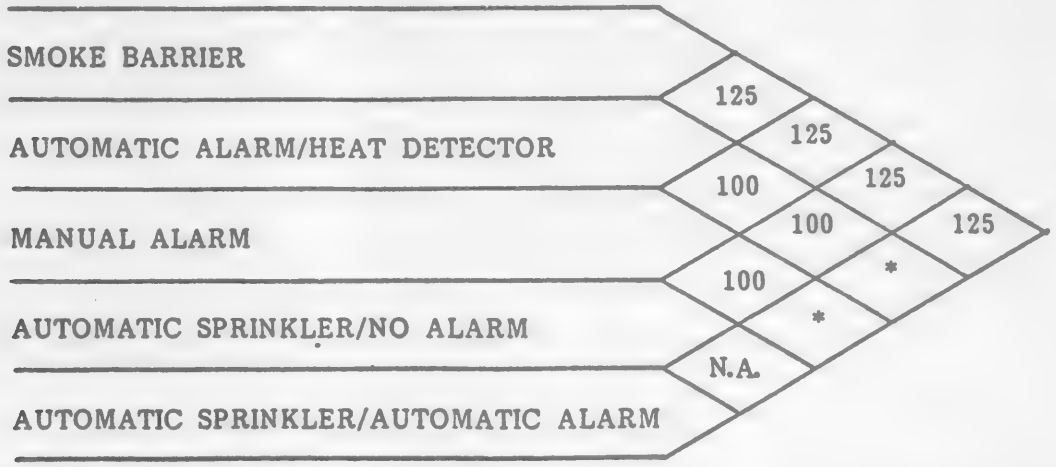
Provide Additional Exit(s)

Solution: Provide additional exit(s) (e.g., stair, fire escape, fire balcony) located so that travel distance limitations are not exceeded.

Discussion: The quality of the additional exits (e.g., enclosed stair v. escape ladder) will depend upon the use and occupancy of the building. If a high quality exits is provided (e.g., enclosed stair) single station smoke detectors need not be provided, unless otherwise locally required.

Suggested Cumulative Increases

The following chart contains the suggested cumulative increases if more than one solution is implemented.



The two combinations noted by an asterick (*) show no additional increase in travel distance because they perform similar life safety functions, e.g., the heat detector and sprinkler head inside the apartment door. However, there is an increase in reliability: there is a second system present should the first device fail to operate. There are also different fire scenarios where one system would be more responsive or appropriate than the other. The increase in travel distance is best left to the informed judgment of the local official, applied to the particulars of a specific structure.

8. *Dead-End Travel*

Summary of Code Requirements and Intent

Code Intent. Dead-end corridors of any length are undesirable features in buildings for two reasons. People who must use a dead-end corridor as part of the exit access (no choice of travel to exits) could be trapped by a fire or smoke between them and the exits. The other reason is that people moving within the exit access could enter the dead-end, especially under smoky or low light conditions, and become trapped or confused. Some controversy exists as to which concern the codes are intended to address, if not both. The answer is important because the design solutions differ.

All the codes use the term "dead-end" but do not define it. The Life Safety Code also uses the phrase "maximum single path corridor length", which would indicate a concern for the availability of two remote exits. The model codes appear to focus upon the individual who may turn off onto a dead-end corridor or hallway.

Code Analysis and Summary. The Basic, Uniform and Standard Building Codes impose a 20-foot maximum length for dead-ends (BOCA: 610.2; UBC: 3304(e); SBC: 1104.3). The Life Safety Code imposes a maximum single path corridor length of 30 feet, except that lengths of 35 feet are acceptable in existing or totally sprinklered buildings. (11–3.5, 11–3.6, 11–3.7, 11–3.8, as changed by the Tentative Interim Amendment)

Identifying Existing Conditions

There are two approaches to the identification of paths of dead-end travel. The result may not be the same in both instances.

From the perspective of an occupant in a corridor moving towards a proper exit(s), a dead-end is any path of travel onto which the occupant could mistakenly turn that does not lead to an exit. The length of the dead-end is the maximum distance that the occupant could travel before realizing the mistake, i.e., to the end of the dead-end path.

From the perspective of an occupant moving from an individual dwelling unit into the corridor, a dead-end is any path of travel for which no choice of exits exists, assuming that two or more exits are required. That is, an exit can be reached by traveling in one direction only. The length of the dead-end is the maximum distance that any occupant entering onto the corridor would have to travel until paths to remote exits become available. The dead-end corridor may extend beyond the most remote point of access from a dwelling unit to the corridor, e.g., to a window or janitor's closet. However, it is assumed that the occupants, familiar with their surroundings, would move toward, not away from the nearest exit. Therefore, for this perspective only, the length of the dead-end does not include the length of the path that does not lead to an exit. It would be included under the approach in the previous paragraph.

Representative Problems and Suggested Solutions

8.1 *Problem:* Excessive lengths of dead-end travel.

Solution: Provide an additional exit to eliminate the dead-end.

Discussion: The most direct solution is to construct an exit at or near the end of the dead-end path. A person turning off the main corridor would still have access to an exit; a person leaving an individual dwelling unit would have a choice of two remote exits. This exit must be directly accessible from the corridor or hallway. Higher quality exit components such as enclosed or exterior stairs are preferred. Fire escapes or balconies could be accepted depending upon the nature and characteristics of the occupant loading, fire department capabilities, building height, etc. If high quality exits are provided, single station smoke detectors need not be provided, unless otherwise locally required.

Solution: Construct a physical partition limiting the path of dead-end travel.

Discussion: By constructing a physical partition, a person who mistakenly turns off the proper path onto a dead-end would be alerted to his mistake. The distance from the proper path to the partition must be within the limits for dead-ends specified within the respective codes, but should be less than that allowed whenever practicable. The partition need not have any fire resistance rating. Any doors may be kept in the open position provided they shall close automatically upon the activation of a local smoke detector. The partition shall be clearly marked to indicate the path is NOT AN EXIT.

This solution does not provide two remote exits for those occupants whose dwelling units access onto the dead-end path. While the codes are not clear on this issue, the following analysis has been used. The portion of the building served by an excessive dead-end path is analyzed as though it were the second story of a two story building. Then, the number of exits required for this portion is determined. The conditions for allowing a single exit are noted in Section 1: NUMBER OF EXITS. If only one exit is required, then the building is considered to be in compliance because the dead-end path still provides one path of escape. The Uniform Building Code provides that "every building or USABLE PORTION THEREOF shall have at least one exit". (3302(a)) (emphasis added) Two exits are required only when certain limits are exceeded.

Travel distances for the dwelling units in this portion of the building are computed as follows:

The regular travel distance limitations outlined in Section 7: TRAVEL DISTANCE must still be met. For example, the travel distance from the door of the most remote dwelling unit in that portion of the building to the nearest exit may not exceed 100 feet in a non-sprinklered building constructed under the Basic Building Code.

Some codes impose a special limitation on travel distance to an exit when only one exit is required. The distance from the door of the most remote dwelling unit to the point where two remote exits become available must not exceed this limit. The Uniform Building Code has no such limitation. The allowable distances in the Basic and Standard Building Codes are 50 feet and 30 feet, respectively. Though the Life Safety Code allows dead-ends of 35 feet in existing buildings, the maximum travel distance when a single exit is allowable is only 20 feet.

Should the analysis reveal that the conditions for a single exit are not met by this portion of the building, then an additional exit must be provided.

9. *Corridors and Exterior Exit Balconies (Separation and Fire Resistance)*

Summary of Code Requirements and Intent

Corridors in Group R (Residential) occupancies are the common and public spaces through which occupants travel from their apartments to an exit element. It is the length of corridors that is usually controlled by code provisions governing travel distance.

The codes establish certain requirements for the separation of corridors from other building spaces. See also Section 10: EXIT CAPACITY/ WIDTHS for dimensional requirements for corridors.

Code Intent. Fire resistance requirements for corridor enclosures and doors are intended to maintain the integrity of the corridor and prevent flames and smoke from blocking the exit route. This will enable the occupants to safely travel through the corridors to the exits.

Code Analysis

Basic Building Code—1978

A corridor is defined as "a hallway, passageway or other compartmented space providing the occupants with access to the required exitway of the building or floor area". (201.2)

Corridors serving more than 30 occupants (i.e., floor area greater than 6,000 sq. ft.) must have a fire resistance rating of one hour. Corridor walls must extend from the floor to the ceiling (need not extend through space above suspended ceiling). Doors opening onto corridors serving over 30 occupants must be self-closing or automatic closing, with a 20-minute fire protection rating. (610.4)

Open porches or balconies leading to exterior exitway stairs must be separated on their interior side by a fire resistance rating of one hour in buildings of three stories or less, and of two hours in all other buildings. Doors in such separations must be rated ¾ hour and 1½ hours, respectively. Other openings must be protected and are limited in area. (619.1.1)

Uniform Building Code—1979

Corridor is not specifically defined.

Walls of corridors and interior sides of exterior exit balconies serving an occupant load of 30 or more (i.e., floor area 6,000 sq. ft. or more) must be of not less than one-hour fire resistive construction. Ceiling of corridors must be at least that required for a one-hour fire resistive floor/ceiling assembly.

Where corridor walls are required to be of one hour fire-resistive construction, doors must be "tight-fitting smoke and draft control" self-closing or automatic closing assemblies with a 20-minute fire protection rating. Other openings in corridor walls must be fixed and protected by ¼-inch wired glass in steel frames and may not exceed 25% of the wall area separating any room and the corridor. Protection of openings in the interior walls of exterior exit balconies is not required. (3304)

Travel distance in an enclosed corridor may be increased (see Section 7: TRAVEL DISTANCE).

Standard Building Code—1979

Corridor is not specifically defined.

All exit access corridors serving over 30 occupants (i.e., floor area greater than 6,000 sq. ft.) must have a minimum fire resistance rating of one hour. An exterior balcony may serve as a corridor (exit access) if it complies with all the requirements of a corridor. Doors opening onto corridors serving over 30 occupants must be self-closing, tight fitting, smoke and draft assemblies with a 20-minute fire protection rating. (702.3, Table 700 and Notes, 1108)

NFPA Life Safety Code—1976

Corridor is not specifically defined.

Walls enclosing exit access corridors must have a fire resistance of 1 hour. The fire resistance may be reduced to ¾ hour and ½ hour for buildings with automatic detectors and automatic sprinklers, respectively; ½-hour fire resistance is permitted in existing buildings.

Doors opening onto such corridors must have a 20-minute fire protection rating, except that previously approved 1¾ inch rated bonded wood core doors and frames may remain in use. Doors between apartments and corridors must be self-closing. (11–3.2.8, 11–3.5.3.1.3 and Exception No. 2, 11–3.6.3.1.3, 11–3.7.3.1.3, 11–3.8.3.1.2)

Summary. The Basic and Standard codes require a 1-hour enclosure and 20 minutes for doors for corridors serving over 30 occupants; the Uniform Code applies similar requirements when the occupant load is 30 or more. The Life Safety Code requires a similar corridor enclosure, irrespective of occupant loading, but allows reduction of the separation requirement as a function of automatic detection and extinguishment. Only the Life Safety Code accepts lower ratings for existing buildings. All codes require doors to have some form of door closing mechanism.

The three model codes disagree on the treatment of exterior exit balconies. The Uniform and Standard Codes treat them as corridors, while the Uniform Code does not require openings in interior walls of exterior exit balconies to be protected. The Basic Code seems to be stricter, treating them as parts of "exitways" rather than "exitway access".

Identifying Existing Conditions

Determine the occupant load served by the corridor in question. If it is in excess of the code specified criteria of 30 occupants (or 6,000 sq. ft. of area served), proceed with the following:

- Determine the fire resistance rating of the corridor wall assembly by reference to the code in effect, current listings or the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*
- Identify all other openings in corridor walls, such as transoms, and determine their area and the design of their closing devices, if any.
- Determine the presence and operability of door closing devices.

Selected Problems and Representative Solutions

9.1 *Problem:* The fire resistance of the corridor enclosure, as determined above, is below that required by the code in effect.

Solution: If the existing corridor wall consists of wood lath and plaster in good condition, it should be accepted as having adequate fire resistance. If of lesser construction or in need of repair, the fire resistance of the corridor enclosure should be improved by repairing the existing construction or adding a new layer(s) of fire rated materials. See the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

Discussion: If the fire resistance is upgraded to code requirements, single station smoke detectors need not be installed, unless otherwise locally required.

Solution: A corridor enclosure of 30 minutes fire resistance should be accepted. Buildings with more than three occupiable floors must be equipped with an automatic fire alarm system activated by heat detectors located inside every apartment door to the corridor. The alarm should notify all building occupants. Entrance doors to apartments should be equipped with door closers.

Discussion: The door closers, single station smoke detectors, and automatic fire alarm system (when required) will provide earlier detection and alarm and increase the reliability of the compartmentation. The corridor walls should be carefully inspected to insure that they extend from the floor to the underside of the floor above, are properly firestopped, and that any poke-throughs or penetrations are properly protected. There should not be any other serious code deficiencies.

9.2 *Problem:* The fire protection rating of corridor doors is lower than that required by the code in effect.

Solution: Unrated corridor doors should be accepted if they are individually equipped with a local sprinkler which will spray the door in case of a fire on the room side of the corridor door. Such a sprinkler may be connected to the domestic water supply system and need not sound an alarm upon activation. Doors should be provided with self-closing devices.

Discussion: The water spray on the exposed surface will compensate for the reduced fire resistance rating.

Solution: Upgrade the existing corridor doors. See the *Guideline on Fire Ratings of Archaic Materials and Assemblies.*

9.3 *Problem:* The corridor walls have openings other than doors which are inadequately protected as required by the code in effect.

Solution: All transoms should be closed with plasterboard, fixed wire glass, or other like materials. Other openings should be improved by repairing the existing construction or adding a new layer(s) of fire rated materials.

Discussion: See the *Guideline on Fire Ratings of Archaic Materials and Assemblies* for guidance. If the fire resistance is upgraded to code requirements, single station smoke detectors need not be installed, unless otherwise locally required.

Where the sealing of transoms or the use of wire glass would seriously compromise the character of a building, flexibility should be shown. Partial sprinkler systems or alternate materials such as polycarbonate could be considered. Single station smoke detectors would still be required unless the fire performance of these materials or systems is documented as meeting code requirements.

10. *Exit Capacity/Widths*

Summary of Code Requirements and Intent

The codes regulate the capacity of the means of egress by relating required widths of the various elements of the means of egress to the occupant load they serve, and by establishing minimum widths for each egress element.

Code Intent. It is the intent of the codes to provide an exit capacity large enough to move the total expected occupant load into the exits before the access to exits becomes untenable.

Safe exiting time is implied in the codes only, and cannot yet be validly calculated. It was, however, discussed when the values for exit capacity were established by the NFPA Life Safety Code committee. Doors and other level egress components were considered to have a rated capacity of 60 persons per minute per 22 inch unit of exit width, and stairs were rated at 45 persons per minute per unit of exit width. This is considered a standard 4:3 ratio for pedestrian movement. These values are based on studies by the National Bureau of Standards and the London Transport Board. (National Bureau of Standards, *Design and Construction of Building Exits, Pub. No. M151,* Washington, D.C., NBS, 1935; London Transport Board, *Second Report of the Operational Research Team on the Capacity of Footways Research Report No. 95,* London: London Transport Board, 1958). If stairs are sized to a capacity of 75 people per unit, a time of 100 seconds is implied (75 people/unit divided by 45 people/minute-unit). The results are the same for corridor travel.

The 22 inch unit of exit width, which is used in all but the Uniform Building Code, represents the median width of the human body at shoulder height. Its origin is said to be in experience gained by the military.

The UBC requirements actually imply an exit capacity of 100 people per 24 inches of exit width. Using the 22 inch exit unit system this results in about 92 people per exit unit.

Code Analysis

Basic Building Code—1978

Capacity is based on a unit of egress width of 22 inches with 12 inches or more considered as ½ unit in addition to one or more units (608.1), except that a 40-inch door is considered to have two units of egress width.

Exit capacity (number of occupants) per unit of egress width (608.2):

	Without fire suppression system	With fire suppression system
Stairways	75	113
Doors, ramps, corridors	100	150

Minimum width:
- Corridors, ramps—44 inches (36 inches in 1- and 2-family dwellings)
- Door—32 inches (28 inches in 1- and 2-family dwellings)
- Stairway—44 inches (36 inches for occupancy load 50 or less)
- Fire escape—22 inches
- Passageway—44 inches or ¾ of aggregate widths of all stairways and doorways leading thereto, whichever is greater

Uniform Building Code—1979

The total width of exits (in feet) cannot be less than the total occupant load served divided by 50, divided about equally among the separate exits. The total exit width for any story is based on the occupant load of that story, plus a percentage of the occupant load of other floors which exit through the story under consideration: 50 percent of the first adjacent story above (and below, if applicable), and 25 percent of the story immediately adjacent to the first adjacent story. (3302(b))

Minimum width:
- Corridors, exit balconies, and passageways—44 inches for occupant load of 10 or more (36 inches within dwelling units) (3304(b))
- Doors—32 inches
- Stairways and ramps—44 inches for occupant load over 50; 36 inches for load of 50 or less (30 inches for private stairway) (3305(b))
- Exit courts—44 inches or tributary occupant load
- Fire escape (existing building only)—29 inches—clear access opening; 18 inches—stairs (Appendix Chapter 12, 1215(h))

Standard Building Code–1979

Capacity is based on a unit of egress width of 22 inches with 12 inches or more considered as ½ unit in addition to one or more units (1105.2)

Exit capacity (number of persons) per unit of egress width (1105.3):

Stairs.....75
Level travel (doors, ramps, corridors).....100

The minimum width:
- Any means of egress—36 inches (1105.3(e))
- Exitway access, corridors, ramps—44 inches (36 inches in 1- and 2-family dwellings) (1105.3(g))
- Stair—44 inches (36 inches for 50 or less occupants (1115.6(c))
- Courts, passageways—36 inches or aggregate capacity of all tributary means of egress (1112(c)); 44 inches or ¾ of aggregate tributary stair and door width (1128.2)
- Door—32 inches (1117.1(b))
- Fire escape—22 inches—stairs (1116(d))

NFPA Live Safety Code—1976

Capacity is based on a unit of exit width of 22 inches with 12 inches or more considered as ½ unit in addition to one or more units (5–3.2)

Exit capacity (number of persons) per unit of exit width (11–1.6.1):
- Level egress, class A ramps, doors—100 People
- Stairways and other types of exits—75 People (See Table 5–2.9.4 for fire escapes)

Minimum width:
- Any exit access, Doors—28 inches (currently being changed to 32 inches)
- Stairs—44 inches for occupant load of 50 or more; 36 inches for occupant load of less than 50 (5-2.2.1.2)
- Fire Escapes—22 inches (18 inches for 20 or less occupants (5–2.9.4)
- Ramps—44 inches for Class A (5–2.6.1.2) 30 inches for Class B (5–2.6.1.2)
- Exit Passageway—Aggregate of tributary capacities (5–2.7.3)
- Street floor exit—Aggregate capacity of street floor and ¾ of exit units of stairs from other floors discharging through street floor (11–2.2.3.1)

Summary

Three of the codes use the 22-inch exit unit in computing required exit widths. The Uniform Code differs from the other three codes in the method used; however, the resulting widths are close. Only the Basic Code allows an increase in the capacity per unit of egress width if the building is sprinklered.

Minimum widths are generally similar for all the codes, except that the Life Safety Code, as currently revised, accepts a minimum corridor width of 32 inches. The other codes require 44 inches in apartment buildings.

Identifying Existing Conditions

- Determine the number of exit units or feet of exit (depending on the code in effect) for each exit element identified in Section 1: NUMBER OF EXITS above; for each access corridor or hallway leading from any apartment to an exit; and for each grade level egress. Base the computation on the number of occupants served by the element in question, in accordance with the code in effect. When communicating stairs or other openings are present, attention must be given to the potential need for the simultaneous evacuation of multiple floors.
- Determine the required width of each egress element, corridor or hallway.
- Determine or measure the actual width of each egress element, corridor or hallway, and grade level egress identified above, by field measurement or scaling dimensioned plans.

Selected Problems and Representative Solutions

10.1 *Problem:* The width of a particular existing element, or a new element constrained by structural or architectural features of the building, is less than the minimum width specified in the code in effect.

Solution: If the element is wide enough to provide the required exit capacity and is equal to or greater than some minimal dimension, though lower than that specified in the code, it should be accepted. This new minimum should be over 22 inches. Twenty-eight inches should be considered, as formerly specified for some elements by all four codes.

Discussion: In most cases, considerations of functionality (movement of furniture, etc.), appearance, marketability, and accessibility to the handicapped will result in minimum dimensions greater than those suggested above, and may in fact, have been the reason for the higher minimums specified in current codes. For egress only, however, one unit of exit width should be adequate given the lower occupant loading. A higher minimum than 22 inches is suggested, since that dimension represents a median width of the human body at shoulder height.

11. *Construction Details and Specifications*

Summary of Code Requirements and Intent

Code Intent. The codes set out many other requirements for egress components. Typical areas include: allowable materials, handrails, tread and riser design, landings, platforms, guards, door hardware, signage, lighting, alarms, and emergency lighting. The intent of these provisions is to ensure a quality design that will promote safe and easy passability. The individual code requirements have not been set out because they are too numerous and highly specific.

Identifying Existing Conditions

The relevant features should be noted on the building plans or may be studied by a visual inspection of the physical structure.

Selected Problems and Representative Solutions

Because these provisions tend to be highly specific and detailed, existing egress components will often not be in compliance. However, the impact or effect of the deficiency must be realistically appraised in light of the number of occupants that will rely upon the egress component in question and their ability to use the egress component as it presently exists. If the numbers are small and the people generally representative of the population at large, then minor deviations should be tolerated.

For additional guidance to understanding potential problems and solutions related to stairway design, refer to NBS Building Science Series 108, *"Safety on Stairs"*, November 1978, and Building Science Series 120, *"Guidelines for Stair Safety"*, May 1979, National Bureau of Standards, U.S. Department of Commerce.

Of the many potential problems, there are three that appear the most common and raise the greatest concern.

11.1 *Problem:* Existing winding and/or spiral stairs not permitted by the code in effect.

Solution: Allow their continued use if occupants are generally representative of the population at large (mobile, agile, and capable of rapid movement under emergency condition); upgrade stairs in all other respects, particularly handrails and lighting.

Discussion: Winding or spiral stairs are not favored because the uneven tread pattern and changes in direction can make passage difficult. The use of these stairs could be continued if the occupants can be expected to use them safely and the stairs complied in other respects (e.g., not excessively steep or narrow). Lighting should be improved if necessary; emergency lighting, handrails, etc. should be improved or provided.

11.2 *Problem:* Non-conforming tread and riser dimensions.

Solution: Accept stairs which are steeper than those permitted by the code in effect. Handrails should be provided on both sides, and stairs should be upgraded where necessary. See Section 10: EXIT CAPACITY/WIDTHS for stairs less than the required minimum.

Discussion: All codes contain minimum tread and maximum riser dimensions. Some codes use the mathematical formula that the sum of (2 x rise) + run must be between 24–25 inches. Such criteria may arbitrarily eliminate stairs which are otherwise quite passable. Rather than the absolute values of stair dimensions, it is the non-uniformity of tread or riser dimensions within a given flight of stairs which is a major cause of stairway accidents. Non-conforming stairs may be considered for acceptance if they are uniform, and the occupancy is such that those who may need the stairs in an emergency are familiar with the particular characteristics. As in 11.1 above, the stairs should be otherwise of high quality and passable. Lighting should be improved if necessary; emergency lighting, etc., should be improved or provided.

11.3 *Problem:* Ceiling heights for stairs, passageways, etc. are lower than minimum specified by the code in effect.

Solution: Allow the continued use if passable by the occupants, provided the ceiling height is no less than the minimum door height specified by the code in effect.

Discussion: Low ceiling heights make an exit not only physically difficult to traverse, but can create an impression of closeness or of a closed space that may create a sense of apprehension, particularly if the path is also narrow or somewhat lengthy. If the number of occupants is low so that crowding would not be expected and the distance is not excessive, discretion should be exercised. The familiarity of the occupants with this egress component should also be considered. Lighting, particularly emergency lighting, is very important. A regular pattern of markings showing the direction of the ultimate exit to the outside can also be reassuring. Other aspects of the egress component should be improved or provided if missing.

Electrical Guideline for Residential Rehabilitation

Introduction

This guideline addresses only those select problem areas most identified with rehabilitation projects. The guideline is not a code, but like an electrical code, it is intended for use by persons knowledgeable about electrical design and installations. In general, the guideline addreses three subjects:

- setting and adopting electrical rehabilitation standards at the state or local level;
- inspecting existing electrical installations; and
- problems and solutions for hazardous conditions, adequate load-carrying capacity, and additions, alterations and extensions to existing electrical installations.

With regard to problems and solutions, this guideline is intended to be used in all types of residential occupancies except hotels, rooming houses, dormitories and housing for the elderly. Its use is intended to facilitate rehabilitation by the maximal re-use of existing installations in circumstances where, for some reason, code requirements for new construction are being applied to a project undergoing rehabilitation. In general, there are two such circumstances:

- repair and improvement of existing residential buildings when compliance with the code requirements for new construction is triggered by a 25–50% Rule or similar rule which is in effect in the jurisdiction; or
- change of use or occupancy into a residential occupancy (e.g., from one- and two-family dwelling to apartment building, from hotel to apartment building, etc.) when compliance with the code requirements for new construction is triggered by the provisions of the code in effect or some other provision.

In the latter circumstance (change of use or occupancy), this guideline should be used when it is feasible to reuse some portion of an existing electrical installation.

It has been long recognized that electrical codes pose special problems for rehabilitation projects. Some communities have adopted special electrical codes to be used for rehabilitation. For example, the City of Detroit's electrical code for rehabilitation is shown in Appendix 1 to this guideline. Some of the model electrical codes give the code enforcement authority the responsibility for making interpretations of the rules, for granting exceptions to the rules, and for waiving specific requirements of the code. An example of this "flexible" approach is provided by the National Electric Code (NEC):

- "Section 90–2.(c) Special Permission. The authority having jurisdiction for enforcing this Code may grant exception for the installation of conductors and equipment, not under the exclusive control of the electric utilities and used to connect the electric utility supply system to the service entrance conductors of the premises served, provided such installations are outside a building or terminate immediately inside a building wall."
- "Section 90–4. Enforcement. This Code is intended to be suitable for mandatory application by governmental bodies exercising legal jurisdiction over electrical installations and for use by insurance inspectors. The authority having jurisdiction of enforcement of the Code will have the responsibility for making interpretations of the rules, for deciding upon the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules."
- "Section 90–5. Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this Code, the National Electrical Code Committee has established interpretation procedures."

1. Establishing Standards for Electrical Rehabilitation

A community that may wish to use this guideline may also have a need to set standards for rehabilitating electrical installations. A process for doing this is discussed in detail in the *Guideline for Setting and Adopting Standards for Building Rehabilitation.*

In addition to the information in this guideline that a community may use to establish suitable requirements and criteria for rehabilitation, there are a number of other sources of information which may be used as a basis for setting electrical rehabilitation standards. Current electrical codes, such as the NEC, are one such source of rehabilitation standards information. Although these codes principally regulate new construction, and therefore may not adequately address the problems of rehabilitating existing buildings, certain of the provisions of electrical codes for new construction may be applicable. For example, those provisions regulating grounding, feeders and service ratings can be adopted as electrial rehabilitation standards when a community wishes to maintain a level of performance in rehabilitated buildings which is the equivalent to that for new construction.

In addition, the "alternative materials and methods" provision of new construction codes provides a concept by which some solutions to problems of electrical rehabilitation can be developed that are different from those prescribed by the current code.

Property maintenance codes, fire prevention codes, and hazard abatement codes could be another basis for setting electrical rehabilitation standards. As the following excerpts from some of these codes illustrate, they do not contain precise enough information to be useful in setting specific standards. They are useful, however, as a general basis for establishing both minimum levels of performance and levels of performance less than that required by new construction codes.

The BOCA Basic Property Maintenance Code states in Section H–602.0, ELECTRICAL FACILITIES:

"H–602.1 Outlets required: Where there is electric service available to a structure, every habitable room of a dwelling unit, and every guest room, shall contain at least two (2) separate and remote outlets, one (1) of which may be a ceiling or wall-type electric light fixture. In a kitchen three (3) separate and remote wall-type electric convenience outlets or two (2) such convenience outlets and one (1) ceiling or wall-type electric light fixture shall be provided. Every public hall, water closet compartment, bathroom, laundry room or furnace room shall contain at least one (1) electric light fixture. In addition to the electric light fixture in every bathroom and laundry room, there shall be provided at least one (1) electric outlet."

"H–602.2 Installation: All electrical equipment, wiring, and appliances shall be installed and maintained in a safe manner in accordance with all applicable laws. All electrical equipment shall be of the approved type."

"H–602.3 Defective system: Where it is found, in the opinion of the building official, that the electrical system in a structure constitutes a hazard to the occupants or the structure by reason of inadequate service, improper fusing, insufficient outlets, improper wiring or installation, deterioration or damage, or for similar reasons, he shall require the defects to be corrected to eliminate the hazard."

Similarly, the BOCA Basic Fire Prevention Code states in Section F–105.0, ORDERS TO ELIMINATE DANGEROUS OR HAZARDOUS CONDITIONS, F–105.1 General:

"Whenever th fire official or his designated representative shall find in any structure or upon any premises dangerous or hazardous conditions or materials as follows, he shall order such dangerous conditions or materials to be removed or remedied in accordance with the provisions of this code: . . . 7. hazardous conditions arising from defective or improperly used or installed electrical wiring, equipment or appliances;"

Past electrical codes for new construction are an expecially important source of information for setting electrical rehabilitaton standards. The levels of safety required by past electrical codes are different from, and may be lower than, the current electrical codes. Past codes, however, are most useful in determining after an on-site inspection whether an existing building currently meets the code under which it was built.

Finally, laws and regulations affecting electrical installations which apply retroactively to exiting buildings are by definition mandatory standards for electrical rehabilitation.

2. Inspection

In the process of submitting proposed electrical rehabilitation work to an authority having jurisdiction, it will be necessary to inspect existing electrical

installations when the authority needs more information about the work to be done (see *Guideline for Approval of Building Rehabilitation*). Inspections are also an essential part of enforcing property maintenance, fire prevention and hazard abatement codes.

This part of the guideline contains a procedure for conducting inspections of existing electrical installations to determine their physical condition, functional condition and load-carrying capacity.

Even if electrical construction drawings and/or specifications of an existing building are available, they are not always be useful for determining the present physical and functional condition of the electrical installation; these conditions can only be determined from an on-site inspection. However, if it is determined that electrical construction drawings accurately and completely represent the present electrical installation in an existing building, they could be used in conjunction with the current electrical code to calculate the installation's load-carrying capacity.

It is recommended that inspections be made by qualified electrical personnel, as determined by each jurisdiction.

2.1 Physical Condition—Step 1

Determine the physical condition of the existing electrical installation including individual dwelling units and common areas of multi-family dwellings. Inspect the physical condition of the parts of the installation which are normally exposed to view.

Next turn off the power of individual dwelling units and common areas of multi-family dwellings, and remove the covers and open the doors of switchboards, panelboards, cabinets and boxes. Inspect the physical condition of the exposed, internal components and wiring, as well as the surrounding building construction.

If the condition of the conductor insulation can't be determined by inspection, perform an insulation resistance test. Similarly, if the condition of receptacles can't be determined by inspection, test them by inserting a standard type flexible cord attachment plug.

Detach fixed utilization equipment such as lighting fixtures, lampholders and appliances (built-in electrical space heaters for example) to inspect the physical condition of their exposed, internal components and wiring, as well as the surrounding building construction. However, in older buildings, detachment may contribute to, or actually cause, defects in equipment, appliances or wiring. Therefore, consider detaching fixed utilization equipment only when:

(1) Such wiring, equipment or appliance is part of a rehabilitation plan;

(2) Problems are evident from the first inspection of parts which are normally exposed to view; or

(3) Problems of function are evident from inspection or records, or are identified by owners or tenants.

2.2 Functional Condition—Step 2

If the physical condition of the installation seems safe, determine the functional condition with the power on in individual dwelling units and in common areas of multi-family dwellings. Inspecting an installation with the power on is essential to determining its condition.

When a building or dwelling unit is without power because it is unoccupied or an imminent hazard exists, determining functional condition may have to be delayed until after rehabilitation has begun, or an exploratory permit may have to be secured by the building owner from an authority having jurisdiction to turn the power on.

Remove the covers and open the doors on equipment to expose circuit breakers, switches, receptacles and other devices, and conductor splices and connections; then:

(1) Operate circuit breakers, switches, other operable devices and fixed utilization equipment;

(2) Observe the function of operable devices; and

(3) Observe the operation, and assess the operating temperatures of fixed utilization equipment.

Make inspections to determine the physical and functional conditions of existing electrical installations in accordance with the current code, such as NEC Section 110–3(a). Whenever possible, as an aid in assessing an installation's condition, secure information from owners, tenants or from records of jurisdictions having authority about past operating problems that cannot be found easily by inspection, such as the frequency of fuses blowing or short circuits.

2.3 Load-Carrying Capacity—Step 3

Determine the load carrying capacity of the existing electrical installation by calculation in accordance with the current code.

3. Problems and Solutions

3.1 Hazardous Conditions

Problem. The existing electrical installation has any one or combination of the following conditions which are contrary to the intent of properly maintenance, fire prevention and hazard abatement codes:

(1) Equipment or wiring is missing, broken, disconnected, loosely connected, unsupported, not securely fastened in place, corroded, burnt, cracked, split, has evidence of overheating, physical damage or misuse;

(2) Equipment is dirty or contains debris;

(3)Wiring is frayed;

(4) Labeled or listed equipment or wiring is not installed in accordance with any labeling or listing instructions;

(5) Circuit breaker, fuse, switch, receptacle, other device, fixed utilization equipment or wiring is not compatible with the phase, voltage, amperage or type characteristics of the electricity in use;

(6) circuit breaker, switch or other operable device has visible evidence of arcing or overheating;

(7) receptacle contact devices are not firmly in contact with the contact devices of a standard type flexible cord attachment plug when the plug is inserted in the receptacle;

(8) bathroom receptacle, garage receptacle or outdoor receptacle with direct grade level access is without ground fault circuit interruptor protection;

(9) neutral is not grounded at the main service entrance equipment location by a properly connected grounding electrode conductor;

(10) polarity is reversed in wiring connections to receptacle outlets;

(11) fixed utilization equipment, such as a lighting fixture, lampholder or appliance, operates intermittently;

(12) building construction adjacent to wiring, equipment or appliance is burnt;

(13) service, feeder or branch circuit conductors have evidence of intermittent operation, impaired operation or cannot otherwise be determined as acceptable when the installation is energized;

(14) flexible cord is used as a permanent wiring method;

(15) branch circuit, feeder, switchboard, panelboard or distribution board service rating is inadequate for the load calculated in accordance with the current code; or

(16) pull-chain switch or brass shell socket in a wet or damp location is within reach.

Solution. Have all such conditions corrected.

Discussion. These conditions are hazards of varying degrees. They are problems associated with defective or improperly used or improperly installed wiring, equipment or appliances. If any one or combination of these conditions is extensive, severe or occurs frequently

in an installation, an authority having jurisdiction may judge that an imminent hazard exists. In that case, the hazard must be corrected immediately or the installation disconnected.

If flexible cord is used as a permanent wiring method (condition 14), this may indicate the need for more receptacle outlets (see 3.8 of this Guideline).

3.2 Incompatible Conductors, Devices or Equipment

Problem. Circuit breaker, fuse, switch, receptacle, other device, fixed utilization equipment, raceway, connector, terminal, splicing device or other fitting is not compatible with the type of conductor used, or the electrical connection doesn't meet the current code, such as NEC Section 110–14.

Solution. Have all such connections of conductors to terminal parts, conductor splices, or conductors joined with splicing devices corrected to meet the current code, such as NEC Section 110–14(a) and 110–14(b); and have all incompatible conductors, devices or equipment corrected to meet the current code, such as NEC Section 110–14, by:

(1) Replacing existing conductors with new conductors which are compatible with the existing devices or equipment; or

(2) Replacing existing devices or equipment with new devices or equipment which are compatible with the existing conductors; or

(3) Installing an insulated conductor "pigtail" compatible with the existing device or equipment.

Discussion. Improper connections and splices, and incompatible conductors, devices and equipment can be hazardous. There are problems associated with defective or improperly installed wiring or equipment. These conditions, depending upon the number and severity of the problems, may be judged an imminent hazard by an authority having jurisdiction. If that is the case, the hazard must be corrected immediately or the installation disconnected.

3.3 Grounding of Fixed Appliance Branch Circuits

Problem. An existing fixed appliance branch circuit doesn't have an equipment grounding means which is required by the current code.

Solution. Permit ungrounded, non-conforming, existing fixed appliance branch circuits to remain, provided:

(1) Alternative grounding is provided for appliances by the connection of an equipment grounding conductor to a grounded, metallic, cold water pipe;

(2) Service equipment, service raceways, service grounded conductors, switchboards and panelboards are grounded in accordance with the current code, such as NEC Article 250, or alternative grounding is provided by the connection of an equipment grounding conductor to a grounded, metallic, cold water pipe;

(3) Branch circuit equipment grounding conductors are in accordance with the current code, such as NEC Article 250; and

(4) Ungrounded, non-conforming, existing, general purpose branch circuits conform to 3.4 of this guideline.

Discussion. This alternative method of grounding existing fixed appliance branch circuits is not the method usually required by code, but it will provide an equivalent level of safety. And, since this alternative method is relatively simple to install, it is an aid to rehabilitation. But, it's important to make sure in such installations that equipment grounding conductors are connected to *cold* water pipes which are *metal* and which are *grounded.*

3.4 Grounding of General Purpose Branch Circuits or Feeders

Problem. An existing general purpose branch circuit or feeder is without an equipment grounding means which is contrary to the current code.

Solution. Allow ungrounded, non-conforming, existing, general purpose branch circuits or feeders to remain, provided that:

(1) no circuit or feeder is overloaded when the load-carrying capacity is calculated as in 2.3 of this guideline;

(2) no general purpose branch circuit serves loads required by the current code to be served by small appliance branch circuits; and

(3) no receptacle outlet or fixture is located where it will be in reach of grounded surfaces.

Discussion. An existing general purpose branch circuit or feeder without an equipment ground which is inspected, found to be still in acceptable physical and functional condition, and is not overloaded, can be considered to have a history of operating safely. Therefore, its safe operation can be expected to continue, and it may be allowed to remain. It is important that such a circuit doesn't serve as an appliance branch circuit; that in calculating loads on it, both existing loads which won't be affected by rehabilitation, and new loads which are a result of rehabilitation be used; and that the receptacle outlets and fixtures on such a circuit are safely located out of reach of grounded surfaces.

3.5 Undersized Service

Problem. The size of the service is inadequate for the load as calculated according to the current code.

Solution. Recalculate the size of the service for the actual connected (installed) load and the loads for circuits calculated according to the current code, provided:

(1) The service disconnecting means has a rating not less than the actual connected load;

(2) Loads established for branch circuits and feeders are determined with the diversities and calculation methods defined in the current code; and

(3) All other aspects of the service meet the current code, such as NEC Tables 310–16 to 19 including the notes to those Tables, Article 210, Article 220, Article 240 and Article 230 except Section 230–79(c) for single-family dwellings and Section 230–79(d) for all other occupancies.

Discussion. In determining the actual connected load, include both existing loads which won't be affected by rehabilitation and new loads which are planned as a part of rehabilitation. The probability of the use of room air conditioners should also be considered. By using energy sources other than electricity, electrical loads can be reduced. Therefore, consider the use of other energy sources for cooking, heating and domestic hot water. Determining existing loads and new loads planned as a part of rehabilitation requires judgment. If there is any indication that loads will increase in the future, this should be taken into consideration. Using the actual installed load is a means of control otherwise unnecessary rehabilitation, while maintaining the standards of safety required by the current code.

3.6 Second Service Entrance and Disconnect

Problem. In one- and two-family dwellings, the existing service rating is to be increased by the addition of a second service entrance and a second service disconnect in order to meet the current code or this guideline, but space is limited or there are other, similar constraints.

Solution. Add the second service entrance and the second service disconnect at a location different from the existing service disconnect, provided:

(1) Both disconnects meet the current code, such as NEC Section 230–44 and 230–72(a) and (c);

(2) Permanent warning signs are erected at each location indicating separate service disconnects; and

(3) The combined rating of the separate service disconnects is not less than that required by the current code or recommended by other sections of this guideline for a single service disconnect.

Discussion. These recommendations are intended to eliminate the potential hazard of installing a single, new, service entrance in an inappropriate location, and are a means to control otherwise unnecessary rehabilitation. Any hazard associated with a "split" service is also eliminated by the suggested provisions of the recommendations, and the restriction of split service to residences of no more than two families. A split service installed as recommended is an alternative to the current code which may provide an equivalent level of safety.

3.7 Extending General Purpose Ungrounded Branch Circuits

Problem. An existing general purpose branch circuit that is to be extended conforms to the current code, but doesn't have an equipment grounding means.

Solution. Permit ungrounded, non-conforming, general purpose branch circuits to be extended to all locations except kitchens, baths, basements, garages and locations within reach of grounded surfaces.

Discussion. Kitchens, baths, basements, garages and locations within reach of grounded surfaces represent a particular hazard as compared to other locations. That hazard is reduced by equipment grounding means installed according to the current code or this guideline.

3.8 Number of Receptacle Outlets

Problem. The number of existing receptacle outlets is less than required by the current code.

Solution. Permit fewer receptable outlets than required by the current code.

Discussion. The number and location of receptacle outlets required for the safe and convenient use (as this bears on safety) of rooms and spaces varies and can best be determined by the judgment of communities and jurisdictions individually. Such factors as number of occupants, floor area, room configuration, and window and door locations all affect determining that number and location of receptacle outlets which meets the intent of the current code. Examples of such reductions in the number of required receptacle outlets are contained in the BOCA Basic Property Maintenance Code, Section H–602.0, ELECTRICAL FACILITIES which is quoted in 1 of this guideline, and in Appendix 1 to this guideline, Chapter 10, Official Electrical Code of the City of Detroit.

3.9 Access to Electric Equipment

Problem. The configuration of access space to, and working space around, electric equipment to permit ready and safe operation and maintenance of the equipment is different from that required by the current code, such as NEC Section 110–16.

Solution. Permit such existing space to remain when the intent of the current code can be met.

Discussion. Equipment accessibility and working space are essential to safety. If the existing space meets the requirements of the past code under which it was constructed, if additional equipment and/or new equipment of a higher service rating is not to be installed, and if the installation has a history of safe operation, maintenance and repair; these considerations may be a basis for permitting the existing space to remain unchanged.

Appendix 1—Detroit Electrical Code, Chapter 10

Chapter 10 of the code is added as follows:

1000–1. Minimum standards for existing dwelling units.

If inspection reveals that the wiring system of an existing dwelling type occupancy is inadequate, or if code certification as a habitable dwelling under this section is requested, the following minimum requirements shall be complied with:

(a) **Entrances and Exits:** Where two (2) or more entrances and/or exits exist, at least two (2) entrances and/or exits shall be illuminated by exterior lights. Lighting outlets shall be controlled by interior wall switches, located for convenient and readily accessible use.

(b) **Living Room:** Living room shall be provided with illumination. Lighting outlet shall be controlled by a wall switch, located for convenient and readily accessible use. One of the receptacle outlets controlled by a wall switch in lieu of ceiling lighting outlet is acceptable. Convenient duplex receptacle outlets shall be provided. Receptacle outlets shall be equally spaced around the room with at least one duplex receptacle outlet on each wall.

(c) **Kitchen:** Kitchen shall be provided with illumination. Lighting outlet shall be controlled by a wall switch located for convenient and readily accessible use.

A separate kitchen appliance circuit shall be provided, supplying a minimum of three (3) grounding type duplex receptacle outlets. Two (2) of these receptacles shall be readily accessible for convenient use of portable appliances. New appliance circuits shall be twenty ampere capacity.

(d) **Bathroom:** Bathrooms shall be illuminated. Lighting outlet shall be controlled by a wall switch. A receptacle outlet separate from the light fixtures, shall be provided and shall be located at least thirty (30) and not more than forty-eight (48) inches above the floor adjacent to the wash basin and not more than four (4) feet from the basin.

(e) **All Other Habitable Rooms:** Illumination for each habitable room shall be provided. Lighting outlet shall be controlled by a wall switch. Wall switches shall be located for convenient and readily accessible use. Convenience duplex receptacle outlets shall be provided with a minimum of two (2) receptacle outlets equally spaced around the room. An additional receptacle outlet controlled by a wall switch is acceptable in lieu of a lighting outlet.

(f) **Basement:** Basement shall be wired for a minimum of one lighting outlet in each 200 square feet or major fraction of area for use as general illumination. All enclosed areas that may be walked into, such as toilet rooms, fruit storage rooms, utility rooms, excavated areas under porches, etc., shall be provided with at least one lighting outlet (except coal bins).

Stairwell and laundry area lighting outlets shall not be counted as part of the required basement lighting outlets.

(g) **Laundry Areas:** Laundry areas shall be provided with illumination. Laundry circuit shall be an individual circuit. A wall-mounted grounding type duplex receptacle outlet shall be provided, located near the laundry equipment.

An existing drop cord receptacle outlet on a separate circuit shall be acceptable providing it is a grounding type receptacle outlet not more than five (5) feet six (6) inches above the floor.

(h) **Space Heating System:** Heating equipment requiring electrical energy for operation and/or control shall be provided with an individual circuit. A disconnect switch shall be provided on or adjacent to the heating equipment (exception: thermo-pile controlled furnaces).

(i) **Stairwells:** Stairwells shall be adequately illuminated. Lighting outlets shall be controlled by wall switches. Wall switches shall be located for convenient and readily accessible use. Switches shall not be located where it is necessary to use darkened stair sections for their operation. All stairwells to finished portions of dwelling shall be

provided with multiple switch control, one at the head the other at the foot of the stairwell.

(j) **Service and/or Feeder:** Service to existing dwelling unit shall be a minimum of one hundred ampere, three wire capacity, service equipment shall be dead front having no live parts exposed whereby accidental contact could be made. Type "S" fuses shall be installed when fused equipment is used.

Exception: Existing service of fifty-five ampere three wire capacity, and feeders of thirty ampere or larger two or three wire capacity shall be accepted if adequate for the electrical load being served.

(k) **Existing Wiring and Equipment:** Existing wiring and equipment shall be in good repair. Circuit extensions made with flexible cord wiring in lieu of permanent wiring shall be eliminated.

1000–2. **New Work.** All new work shall conform to this ordinance.

1000–3. **Evidence of inadequacy.** Evidence of inadequacy shall be any of the following:

(a) Use of cords in lieu of permanent wiring.

(b) Oversizing of overcurrent protection for circuits, feeders or service.

(c) Illegal extensions to the wiring system in order to provide light, heat or power.

(d) Electrical overload.

(d) Misuse of electrical equipment.

(f) Lack of lighting fixtures in bathroom, laundry room, furnace room, stairway or basement.

Plumbing DWV Guideline for Residential Rehabilitation

I Prologue

Introduction

The Plumbing DWV Guideline for Residential Rehabilitation is intended to be used in all types of residential occupancies. It is not a code, but like a plumbing code, it is intended for use by persons knowledgeable about building plumbing design and installation. Its use should facilitate rehabilitation in circumstances where, for some reason, code requirements for new construction are being applied to the project undergoing rehabilitation. In general, there are two such circumstances:

- Repair and improvement of existing residential buildings, when compliance with the code requirements for new construction is triggered by a 25–50% Rule, or similar rule, which is in effect in the jurisdiction.
- Change of use or occupancy into a residential occupancy (e.g., from one- and two-family dwelling to apartment building, from office building to apartment building, etc.), when compliance with the code requirements for new construction is triggered by the provisions of the building code in effect, or some other provision.

In the latter circumstance (change of use or occupancy), this guideline should be used when it is feasible to reuse existing drainage, waste and vent (DWV) piping in the building, or when existing structural or architectural elements in the building pose physical constraints to the installation of new DWV piping.

Plumbing DWV requirements for new construction in building and plumbing codes are often viewed as major rehabilitation problems. Requirements to install new DWV systems in existing buildings which fully comply with current code provisions often lead to extensive additional structural and finish work. There are several aspects to this problem:

- Existing vent systems may not comply with prevailing code provisions for pipe sizing, connections, use of wet venting, and vent location, although they may provide adequate health and safety as installed and used.
- The installation of new vents and drainage lines, even for new fixtures, may be constrained by the limitations of available space and/or the installed configuration of the existing piping system.
- The cost-effective use of existing DWV systems in rehabilitation projects requires judgment and flexibility by the municipal building department to a greater extent and in a different manner than is required in new construction.

The plumbing DWV and related provisions in various codes, adopted by states and local jurisdictions, are not necessarily consistent with one another. What is permitted in one code may not necessarily be permitted in another. However, the hydraulic principles underlying the functioning of plumbing systems, and the potential health and sanitation hazards involved in DWV systems, are the same.

Alternative guideline solutions to various DWV installation problems typically encountered in residential rehabilitation are presented herein. The application of these guidelines is intended to provide a level of health and sanitation which is generally equivalent to the level intended by current plumbing code requirements, while reusing existing DWV elements as much as is feasible.

These guidelines are based upon accepted plumbing and hydraulic engineering principles in general practice, and upon the experiences of recognized testing facilities. The synthesis of such practices and experiences provides a sound basis for the necessary judgment and flexibility required for implementation of these guidelines.

Arrangement of the Guideline

Because the guideline recommends greater flexibility in meeting the health and safety intent of current codes, an understanding of basic drainage and hydraulic concepts is essential to its use. A general discussion of these concepts precedes the guideline itself.

The guideline is arranged as follows:

1. Determination of Existing Conditions of the DWV System
   - 1.1 Inspection, System Schematics and Preliminary Evaluation
   - 1.2 Testing the Existing System
     - a. Structural Serviceability
     - b. Hydraulic Integrity
     - c. Functional Performance
   - 1.3 Estimating the Capacity of the Existing DWV System
2. Problems and Solutions (Proposed Modification)
   - 2.1 Correcting Existing DWV System Structural, Hydraulic and Functional Defects, and Surcharged Sewers
   - 2.2 Relocating Fixtures
   - 2.3 Adding New Fixtures, Extending Existing DWV Systems and/or Installing New DWV System in Existing Buildings
   - 2.4 Through-the-Wall Venting

Appendix A: Performance Criteria
Appendix B: Examples of Acceptable Practices.

Basic Drainage and Hydraulic Concepts

Function of the Drainage System

The function of the DWV system is to collect spent water from the vartious building fixtures and drains and to convey this waste water to the public sewer or sewage treatment facilities in a safe and efficient manner.

A "safe manner" means collection and transmission without the emission of sewer gases, foul odors, or suds into the inhabitable area of the building. Traps at the entrances to the DWV system provide water seals which prevent the escape of sewer gases. Most codes limit the pressure fluctuation within drainage systems to plus or minus 1-inch of water pressure under design load conditions. A more practical limitation, and the one used in this guideline, is *to limit the trap seal reduction to 1-inch of water under normal conditions of loading.* Acceptance of this concept permits the planning and carrying out of simple field tests on existing systems to determine

their condition, and to provide a basis for approving modified systems in rehabilitated buildings.

An "efficient manner" means the conveyance of waste water and suspended solids without blockage. Efficient transport is a function of both velocity and depth of flow. The generally accepted criteria to ensure efficient performance is to size the horizontal drainage lines such that the velocity of flow is approximately 2 feet per second.

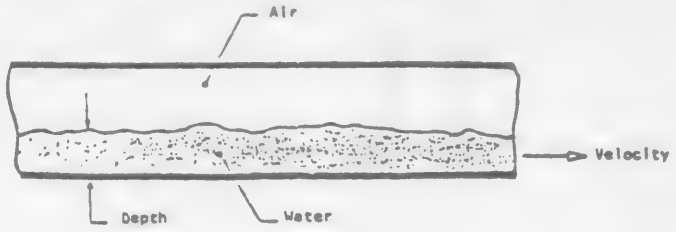
If the depth is not sufficient, solids will settle out. The depth of flow and water velocity are both influenced by the slope or pitch of the drain line. Increasing the slope from ⅛-inch per foot to ¼-inch per foot increases the velocity of the water while it decreases the depth of flow. Knowledge and understanding of these characteristics of flow provides the basis for adjusting the slope of existing building drains, which often determines the capacity of the plumbing drainage system.

Hydraulic Principles

The rate and volume of discharged spent water from plumbing fixtures and drains, as well as the frequency of fixture use, are important variables to the understanding of the functioning of the DWV system. Frequency of fixture use is high in public buildings, such as stadiums and theaters, and low in residential buildings. All fixtures will not operate simultaneously. Estimating fixture use in residential buildings requires only an estimate of the maximum number and combination of fixtures that may discharge simultaneously. In larger buildings, the fixture unit concept is employed. Existing DWV piping systems are not normally loaded to capacity; therefore, they will usually accept a limited number of additional fixtures without seriously decreasing the system's performance. The rate at which water exits from plumbing fixtures changes continuously. For water closets, the discharge typically begins a few seconds after the flush is started and gradually rises to a peak rate of approximately 30 gallons per minute, remaining constant for a few seconds and then gradually falling to zero. The use of water saving closets does not increase drainage problems since their peak discharge rate is similar to conventional fixtures. The discharge time for a typical lavatory is approximately 12 seconds and the peak flow rate is about 10 gallons per minute. This low flow rate and short duration suggest that lavorities have only a small influence on the functioning of the DWV system. Bathtub discharge is influenced significantly by the geometry of the outlet piping, and may have a significant effect due to its long duration. In most outlet arrangements, the rate of discharge rises to approximately 12 gallons per minute almost instantly and thereafter decreases continuously as the tub drains. Water conserving shower heads reduce flow rates, and thereby improve the effects of bathtub discharge characteristics on the DWV system.

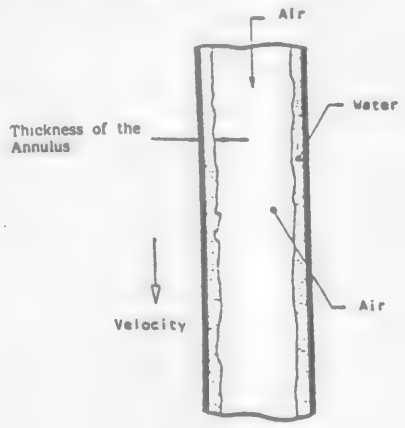
Flow in Drains and Stacks

The flow of spent water in horizontal drainage systems may ber described as separated flow since the horizontal drain is generally only partially filled. Water moves through the lower part of the pipe, while air flows through the upper part.



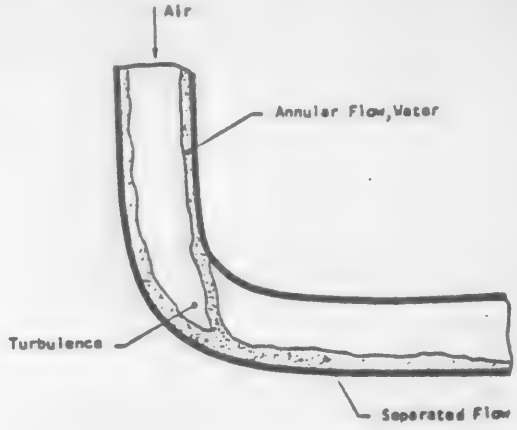
The velocity and depth of the water flow in horizontal drains continually changes. As the volume of water increases, the depth of flow also increases, displacing the air above it. When most of the air space is filled with water, turbulence increases significantly, and even small water pulsations disturb trap seals in the system's plumbing fixtures. Therefore, horizontal drains are designed to flow no more than half full.

The flow in vertical drains or stacks is entirely different. As water enters the stack it attaches itself to the walls of the pipe, forming an annulus. This cylinder of water falls down the pipe, dragging air with it.



The establishment of annular flow is rapid. It occurs within several feet of the point where the water enters the pipe. Increasing the volume of water increases the annulus thickness. When the volume of water occupies approximately ⅓ of the cross-sectional area of the pipe the annular flow breaks down, causing extreme turbulence and pulsations which may result in the loss of trap seals. Small diameter vertical pipes close to fixture outlets are susceptible to breakdown of the annular flow which may result in self siphonage of the fixture. It is for this reason that S traps have been prohibited by codes.

The most critical area in a drainage system is at the base of the stack. In this region the flow must change from the annular flow of the stack to the separated flow of the horizontal drain.



The disturbance at the base of the stack may be large, and significant positive pressures may be generated which, if not relieved, cause blowback—the reversed passage of water through the trap. If the transition is smooth, much of the air is carried away through the horizontal drain.

Horizontal drains are not able to transport spent water at the same velocity as stacks. This results in a phenomenon called hydraulic jump. The change in velocity from approximately 15 feet per second in the stack to 2 feet per second in the horizontal drain forces an increase in the depth of flow. Recently it has been found in laboratory tests that this rise in the water level occurs much further downstream than the generally accepted 10-pipe diameters. What has been observed in the immediate vicinity of the base of the stack is a washing of the sides of the drain which may cause temporary blockage of fixture drains or vents that enter nearby. Fittings rolled up to 45 degrees are effective in avoiding problems in this area.

Modes of Trap Failure

The traps of a drainage system may fail by one or more of the following means:

- *self-siphonage*, or reduction of the trap seal as a result of siphonic action by the discharge of the fixture to which the trap is connected
- *induced siphonage*, or reduction of the trap seal as a result of siphonic action by discharge of fixtures other than the one to which the trap is connected
- *blowback*, or the emission of water, air, sewer gas or suds into the fixture or the inhabited area of the building through the fixture trap
- *cross-flow*, or the movement of waste water from the trap, trap area or branch drain of an operating fixture to the trap, trap area or branch drain of an idle fixture.

The first of these modes of failure, self-siphonage, is a function of fixture and branch piping characteristics. Plumbing fixtures which exhibit a sharp fall off in flow, such as round bottom lavatories, are more sensitive to self-siphonage than those with more gradual changes in flow. Traps serving bathtubs are rarely subject to self-siphonage. Self-venting trap arms and branch drains can be designed to prevent self-siphonage through knowledge of the fixture discharge characteristics and correct pipe sizing and configuration.

Induced siphonage, blowback and cross-flow are prevented through correct venting design and installation. Every drainage system has a basic hydraulic capacity which may be increased by the addition of vents. The function of venting is to maintain close to atmospheric pressure in the drainage system so that trap seals will not be disturbed. A sure way to protect the DWV system is to provide individual fixture vents, an obviously expensive approach. Among the more economical alternatives that have been developed, tested and commonly approved for residential buildings are stack venting and wet venting.

In stack venting, fixture traps are protected by venting provided through the upper portion of the soil or waste stack. Successful installations require that fixtures be connected to the stack independently, in the order of their rate of discharge (those with the highest rate of discharge placed at the lowest point in the module), and at those parts of the stack where the pressure fluctuations are small. Most codes allow stack venting of fixture traps on the top floor of a building.

Wet venting is a technique that uses the drainage pipe itself for venting of selected fixture traps. In practice, wet vents receive only the spent water from fixtures that have a low rate of discharge. These fixtures need not enter the stack independently, and in many installations groups of fixtures connect to a single horizontal branch. A variety of wet vented modules have been developed and accepted by various codes over the years.

Progressive plumbing designes incorporate wet vented and stack vented modules as major DWV

components, supplemented by individually vented fixtures where required by design restraints.

II Guideline

1. Determination of Existing Conditions of the DWV System

In the process of determining the need for and extent of building rehabilitation involving the plumbing DWV system, and of submitting such proposed rehabilitation work to a building department, it will be necessary to determine the existing conditions of the DWV system in the building. This determination is needed by the building owner and designer, as well as by the building official who may need more information about the work to be done (see *Guideline for Approval of Building Rehabilitation).*

This part of the guideline contains discussions of inspection procedures, documentation, testing and methods for estimating system capacity which may be required to determine existing conditions.

1.1 *Inspection, System Schematics and Preliminary Evaluation.* A field inspection of the existing DWV system should be carried out to provide the following general information:

- Overall physical condition of the system.
- Evidence of impaired structural serviceability and hydraulic integrity of parts of the system.
- Configuration and sizing of the system.
- Existence of surcharged sewers.
- Rehabilitation program requirements affecting building structural and architectural elements, as well as the DWV system.

Based upon this inspection, and in conjunction with data from any available plumbing construction drawings and specifications, a schematic diagram of the DWV system should be prepared. Such a diagram will provide information necessary for establishing the following:

- Scope of the system and related building elements.
- The need for modification or amplification of the functional performance test discussed in 1.2 below, and the number of tests to be performed.
- Calculation of the installed capacity and the code-permitted capacity of the installed DWV system, discussed in 1.3 below.

1.2 *Testing the Existing System.* a. *Structural Serviceability.*—In most cases, physical testing to determine structural serviceability of the DWV system is unnecessary. Adequate evidence related to structural serviceability may be obtained by the following:

- Careful attention to those areas where the DWV system is exposed to view.
- Evidence of exposure to freezing temperatures.
- Evidence of fire damage.
- Careful attention to the DWV system's attachments to, and penetrations of, the building structure.

b. *Hydraulic Integrity (Watertightness).*—In addition to the inspection for hydraulic integrity, when all evidence of leaks is to be noted, one or more of the following tests should be performed to determine the watertightness of the DWV system and to locate leaks, if any.

If the DWV system and connected fixtures are intact, perform the *Finished Plumbing Test* described below, keeping in mind that the test method involves a thick pungent smoke, and may be impractical or difficult to perform in a partially occupied building.

If the Finished Plumbing Test cannot be performed on the intact system, perform the *Flow Test* described below.

If the DWV system is not intact, perform the *Rough Plumbing Test* described below.

Each of these tests provides evidence on the watertightness of the DWV system. If the DWV system has been in recent and continuous use and has not developed any leaks, and if the proposed rehabilitation is not extensive, consideration should be given to performing no tests for hydraulic integrity.

Where available, standard test procedures included in the local plumbing code should be followed for each of the tests briefly specified as follows:

Finished Plumbing Test. The test of intact DWV system should be performed by filling all traps with water and then introducing into the system, near the base of the stack, a thick pungent smoke. When the smoke appears at the vent openings, they shall be closed and a pressure equivalent to a 2-inch water column attained. This pressure shall be held for 15 minutes before inspection starts.

Flow Test. The flow test should be performed on all parts of the intact DWV system by filling each fixture within a group to its normal capacity and then discharging the spent water. Where several fixtures are connected to the same branch, the fixtures shall be discharged together.

Rough Plumbing Test. The water or air test conducted on the roughed-in plumbing shall be completed by blocking the lower portion of the system and filling the drainage and vent piping with water. In tall buildings the system should be tested at intervals such that the manufacture's working pressure for the joints is not exceeded, but no section should be tested with less than 10 feet of water except the uppermost 10 feet of the system. The water shall be kept in the system for at least 15 minutes before the inspection starts. The system shall be tight at all points. When using air as a test media, all inlets and outlets must be sealed except where the air pressure apparatus is connected to the system. Air shall be forced in until a uniform gauge pressure of 5 psi is attained. This pressure shall be held for 15 minutes without the introduction of additional air.

c. *Functional Performance.* —DWV systems with proven hydraulic integrity (i.e., proven in accordance with b. above, or repaired in accordance with Section 2.1 of "Problems and Solutions" below) should be subjected to one or more functional performance tests unless they are in compliance with current codes (see 1.3 below). Functional performance tests should be carried out in order to determine the DWV system's resistance to the following modes of failure:

- self-siphonage
- induced siphonage
- blowback
- cross-flow

Test for self-siphonage, and tests for induced siphonage, blowback and cross-flow which may occur on the same floor (i.e., branch pipe testing) should be planned on the basis of analysis of the system schematics discussed in 1.1 above. Tests for resistance to induced siphonage and blowback on different floors (i.e, stack testing) should be carried out for each stack.

The following clear water test is appropriate for back to back bathroom stacks up to ten stories in height. (Increased test loads, introduction of solids and/or suds, and other points of observation should be considered for other types of stacks, based on analysis of the system schematic.):

Functional Performance Test for Bathroom Stacks: (1) Select the required test load from the table below. The test loads are based upon a frequency of the use ratio of 0.01. This frequency of use is consistent with experiences at Davidson Labortory and at the National Bureau of Standard (see Table A5, NBSIR 73–161, "*Field Test of Hydraulic Performance of a Single-Stack Drainage System at the Operation BREAKTHROUGH Prototype Site in Kings County, Washington* "),

and is significantly lower than the test loading requirements of Ch. XVI, Standard Plumbing Code, and British test loading data. For different frequency ratios and related loading requirements, see Table A5 referenced above.

Building Type and Test Load

Single family dwelling—One water closet and one bathtub
Multi-family up to four stories—Two water closets
Multi-family four to ten stories—Two water closets and one bathtub

The fixtures selected for discharge should be those most remote with respect to the building drain in single family homes, and vertically adjacent at the uppermost levels in multi-family dwellings.

(2) Fill all fixture traps. Discharge the selected fixtures simultaneously. Observe and record the trap seal reduction in the idle fixture traps. Reduction of more than one-inch of water is critical and should be recorded. Observe the lower floor water closets for blowback.

Performance tests like the one specified above, carried out in the laboratory on full-scale drainage systems, have shown that trap seal reduction by induced siphonage is greatest in those fixtures located two and three floors below the active fixtures. Blowback, the most common mode of failure, usually is observed in the ground or first floor water closets. Systems near capacity will show trap seal reduction of ¾" to 1" and/or display considerable movement of the water surface in the closets.

Despite extensive experience with laboratory testing, and the inclusion of performance test guidelines in the Standard Plumbing Code (Ch. XVI), standard test instrumentation and procedures have not been developed for performance testing of plumbing systems. If and when such standard methods are developed, the performance testing recommended above should be carried out in accordance with such methods.

1.3 *Estimating the Capacity of the Existing DWV System.* The installed capacity of the existing DWV system should be estimated for two reasons. First, by comparing it to the code-permitted capacity of the installed DWV system, potential code-related problems will become evident. Second, the estimate of the capacity can be used directly in suggesting the system's potential for accepting additional fixtures to be installed as part of the proposed rehabilitation.

The following procedure should be followed:

(1) I identify and count all fixtures connected to each DWV stack. Translate the fixture count into fixture unit values, based on the following table:

Fixture:	Fixture units
Automatic clothes washer	3
Bathtub(w/or w/o 0verhead shower)	2
Bathroom group (incl. tank type water closet)	6
Bathroom group (incl. flushometer valve water closet)	8
Dishwasher	2
Floor drain	2
Kitchen sink (w/ or w/o food-waste grinder)	2
Lavatory	1
Laundry tray	2
Shower stall	2
Sink, service type with floor outlet	3
Sink, service type with P-trap	2
Water closet (tank type)	4
Water closet with flushometer valve	8

(2) Based on the system schematic (1.1 above) identify the existing size of the stack and size and slope of the drain, as well as code required sizes.

(3) Based on the system schematic (1.1 above) determine the type of venting. For the purpose of simplification, the type of venting falls into three categories: single stack with no secondary vents, vents of "unknown" condition, and code-complaint vents.

Vents of "unknown" condition are vents which may be partially blocked, or are otherwise of lesser venting than code-complaint vents.

(4) Based on (2) and (3) above, estimate the fixture unit capacity of the DWV system from the following table (note that this table applies to back to back vertical stack arrangements only):

Stack size	Building drain size @ ¼" slope [1] per foot	Allowable number of fixture units: Single stack [2]	Vents of "unknown" condition [3]	Code—complaint vents
3"	4"	[4]15	[4]30	[4]72
4"	4"	96	150	216
4"	5"	.....	.....	480
5"	5"	.....	.....	480
5"	6"	.....	.....	840

[1] If slope exceeds ¼" per foot, capacity will increase.
[2] Capacity of single stack as found in an existing building. This capacity may be exceeded with engineered single stack systems subjected to final performance tests. Single stack systems are not recommended in locations where building drains are subject to flooding under normal conditions.
[3] The listed capacities may be exceeded if the system does not fail when subjected to final performance tests.
[4] Not more than 3 stories, nor more than 6 water closets.

2. Problems and Solutions (Proposed Modifications)

2.1 *Correcting existing DWV system structural, hydraulic and functional defects, and surcharged sewers.*

(1) *Problem.* Based on the inspection of the existing DWV system (1.1 above), it is determined that the mechanical strength of existing pipes, fittings and supports is appreciably lower than that required for new construction and/or the DWV system is inadequately attached to the building. These conditions may be evidenced by:

- extensive corrosion, scale and other deterioration of wall thicknesses; pipe movement, misalignment, nonuniform slope;
- joint separation;
- other indications of failure;
- evidence of exposure to freezing temperatures;
- evidence of excessive thermal expansion and contraction;
- evidence of fire damage.

Solution. Removal or repair of the damaged parts.

Discussion. Age alone is not indicative of the condition of a plumbing drainage system. Many systems have been found to be in excellent physical condition after decades of service.

(2) *Problem.* Observed reduction of clearances in sleeves and supports, pipe deflection, or other evidence, indicates that the DWV system has been subjected to excessive live or dead loads, above normal service loads.

Solution. Remove such live or dead loads and repair or replace damaged parts.

(3) *Problem.* When subjected to any of the three tests for hydraulic integrity discussed in 1.1.b. above (Finished Plumbing, Flow, or Rough Plumbing Tests), any part of the DWV system is not watertight.

Solution. Repair or remove parts of the DWV system as needed to bring it to a condition of watertightness under the subject tests.

(4) *Problem.* When subjected to any of the functional performance tests as discussed in 1.2.c. above, trap seal reduction of more than one-inch of water (induced siphonage), and/or blowback, self-siphonage or cross-flow are observed in the DWV system, indicating functional deficiency.

Solution. Modify the DWV system, in accordance with Section 2.3 of this guideline, to a condition where it meets all the functional performance tests (see also the Basic Drainage and Hydraulic Concepts section of the Prologue).

(5) *Problem.* Self-siphonage is observed in an S trap that is subjected to a functional performance test.

Solution. Modify the fixture so that the distance between the trap outlet and the vertical drop is at least two pipe diameters but only if the size of the vertical pipe is one diameter larger than the trap inlet. See also Figure 1 of Appendix B for additional information on acceptable practices.

Discussion. The concern for self-siphonage of S traps has led to their prohibition by codes. Self-siphonage in S

traps can be eliminated by the modification described above, which is consistent with National Standard Plumbing Code, 12.8.2.

(6) *Problem.* The inspection reveals that the drainage system of the building is subject to backflow from the public sewer system.

Solution. Approved suitable means such as sewage ejectors, isolation of basement drainage and backwater valves should be employed to prevent backflow from entering the building.

2.2 *Relocating fixtures*

Problem. The proposed rehabilitation, when the existing DWV system is without structural, hydraulic or functional defects (as determined in 1.2 above), and has adequate capacity for its installed fixtures (as determined in 1.3 above), involves the relocation of fixtures without additional load imposed on the system. However, the proposed new fixture location, and the location of existing vertical drain to service that fixture, requires a length of horizontal fixture drain which, if unvented, will exceed that allowed by the local plumbing code.

Solution. For bathroom groups, allow fixture drain lengths at a slope of ¼" per foot, up to the maximum indicated in the following table, provided the connection to the stack is with a sanitary tee or a long turn TY:

Maximum Developed Length of Unvented Fixture Drains

Diameter of drain and length: 1¼ inches—5 feet; 1½ inches—7 feet; 2 inches—10 feet; 3 inches—12 feet; 4 inches—20 feet.

For kitchen (flat bottomed) sinks with or without dishwasher and garbage disposer, allow drain lengths, at a slope of ¼" per foot, up to 12 feet with 2" drain (see illustrations, Appendix B).

Discussion. The concern for self-siphonage in fixtures has led to limitations on lengths of unvented fixture drains. Existing distances as specified in codes may impose a severe restriction on rehabilitation. The smaller diameter fixture outlets of modern installations have reduced flow rates and suggest longer permissible fixture drains.

The data in the table above is based on the following reports: "*Test on Branch Layouts—Investigation of Minimal Tube Diameter*", by O. H. C. Messner, Zurich, Switzerland, April, 1970; and "*An Investigation of the Safety and Durability of the Plumbing Systems in Mobile Homes*", Report SIT-DL-79-9-2079, Stevens Institute of Technology, Hoboken, N. J. (to be published).

Recommended kitchen unit drain lengths are based on "*Plumbing Manual*", BMS-66, U.S. Government Printing Office, 1940.

2.3 *Adding new fixtures to existing DWV systems, extending DWV systems, and/or installing new DWV systems in existing building*

Problem. The proposed rehabilitation, when the existing DWV system is without structural, hydraulic or functional defects (as determined in 1.2 above), involves any combination of the following activities:

- adding new fixtures to the existing DWV system when its capacity exceeds its installed fixtures (as determined in 1.3 above);
- extending the existing DWV system when its capacity exceeds its installed fixtures (as determined in 1.3 above);
- installing new DWV systems in an existing building (whether or not the existing system will continue in use).

However, full compliance with current plumbing codes may lead to extensive sturctural or architectural changes that result in unwarranted additional costs and delays to the rehabilitiation project.

Solution. All additions and alterations to existing plumbing DWV systems should be designed and installed in accordance with Performance Criteria covering the following attributes of the system: (1) Transport of wastes; (2) Durability; (3) Maintainability; (4) Structural serviceability; (5) Hydraulic integrity; (6) Functional performance.

The Performance Criteria are included in Appendix A below.

Alternative acceptable solutions may be found in the following documents, referenced specifically herein:

- Standard Plumbing Code, Chapter XVI, Section 1602—Single Stack Discharge Ventilating Pipe Systems.
- SBCCI and BOCA Research Reports, for automatic anti-siphon trap vent devices.
- NBS BSS-60, "hydraulic Performance of a Full Scale Townhouse System with Reduced-Size Vents", August 1975, for reduced sized venting design.

Appendix B illustrates typical solutions which will comply with the Performance Criteria under most conditions of operation and use, based on engineering analysis and interpretation of test results.

Discussion. Single stack DWV systems, even if complying with the Performance Criteria, are not recommended in locations where building drains are subject to flooding under normal conditions.

2.4 *Through-the-Wall Venting*

Problem. An existing DWV system, an addition to an existing DWV system or a new DWV system in an existing building, may include through-the-wall rather than roof venting. This condition may be determined by inspecting the building or examining existing and/or proposed plans, and is likely to be prohibited by the local code.

Solution. Through-the-Wall venting should be accepted in the following instances:

(a) In historic building where through-roof venting would interfere with the character of the building.

(b) In rehabilitation projects where conventional venting is impractical. In this case, the vents should be at least ten feet horizontally from the lot line and should be turned downward. They should be effectively screened with ¼ inch mesh, to avoid trapping and freezing of any condensation. Through-the-wall vent openings should not be located directly below any door, window or other building opening, nor should any such vent terminal be within ten feet horizontally of such an opening unless it is two feet above the top of such opening.

Appendix A—Performance Criteria

The following Performance Criteria are referenced in Problem 2.3 above.

(1) *Transport of Wastes*

Requirement. Waste water and sewage shall be removed from the building and transported to an acceptable point of disposal without overflowing, accumulating, or backing up into fixtures.

Criteria

(a) Drainage stacks shall carry design loads when flowing less than ⅓ full at terminal velocity.

(b) Horizontal branch drains, and building sewers except horizontal fixture drains, shall flow no more than approximately ½ full under design loads. Horizontal fixture drains shall be sized to give an optimum balance between scouring velocity, diameter and carrying capacity.

(c) Maximum lengths of unvented fixture drains, at a slope of ¼" per foot, shall be in accordance with the table in 2.2 above.

(d) Waste lines likely to carry grease (especially kitchen lines of 2" diameter or less) shall not pass through spaces where they may be subjected to temperatures below the ambient temperature of the occupied space, and all waste lines shall not be subjected to freezing temperatures, unless they are adequately protected.

(e) Vents shall not connect to horizontal drains unless the bases of such vent connections are washed by the discharge from one or more small fixtures.

(f) A uniform, continuous grade of the invert of horizontal drain lines shall be provided.

(g) Fittings, devices, connections and methods of installation shall not obstruct or retard the normal flow of fluids in soil, waste or vent lines.

(h) Waste water or waterborne solids from an active drain pipe shall not pass through an idle trap to a fixture.

(i) Suitable means shall be provided for handling drainage below sewer level. Drainage from parts of drainage systems which cannot drain by gravity into the sewer shall be disposed of through a separate drainage and sewage ejector system, and discharged into the building gravity drainage system.

Test. Determination of conformance to criteria by evaluation of calculations, plans and specifications, inspection of built elements, and conformance to good engineering and trade practices.

Discussion. These criteria have been derived from experience and research on plumbing hydraulics at the Davidson Laboratory, Stevens Institute of Technology, or from standard design practice in general acceptance.

(2) *Durability*

Requirement. The plumbing DWV system and its parts shall have a life expectancy as determined by the local jurisdiction.

Criteria

(a) New plumbing DWV equipment and systems shall be made of materials approved for new construction, free from defective workmanship, and designed and installed so as to be durable, without need for frequent repairs or major replacements.

(b) Before proceeding with an installation, the installer should consult with the local Building Department to determine the durability of materials and joints used under local conditions.

(c) The installer should observe the manufacturer's good practice recommendations regarding handling, storage, installation and adjustment of materials and equipment so that the performance of such products will not be impaired by defects or damage.

Test. Determination of conformance to criteria by inspection of installation and materials, and conformance to good trade practices.

(3) *Maintainability*

Requirement. The design and installation of the DWV system shall provide for cleaning, servicing, adjusting or replacing the various elements, and shall minimize conditions that contribute to soiling, deposition, fouling, clogging, or other maintenance problems.

Criteria

(a) Horizontal drains shall be installed in uniform alignment at a slope in the direction of flow of at least ¼ inch per foot for diameters of 4 inches and greater, to obtain self-scouring velocities. Where such slopes are not attainable, lesser slopes may be used if a mean velocity of at least 2 feet per second can be computed for open channel steady flow at an assumed depth equal to ½ of the diameter.

(b) Access to permit convenient removal of obstructions and fouling matter in horizontal drain lines shall be provided as follows:

- not more than 100 feet apart for larger pipes;
- at each change of direction of the building drain in excess of 45°;
- at or near the foot of each vertical soil or waste stack;
- near the junction of the building drain and building sewer.

Test. Determination of conformance to criteria by evaluation of calculations, plans and specification, inspection of built elements, and conformance to good engineering and trade practices.

(4) *Structural Serviceability*

Requirement. The DWV system shall be capable of withstanding the physical forces that may reasonably be expected in the building during the rehabilitation process and in subsequent use.

Criteria

(a) The mechanical strength of new pipe, fittings and supports shall be similar to that of new construction.

(b) The DWV system elements shall be securely attached to the building.

(c) DWV piping shall not be subject to dead or live loads above normal service loads.

Test. Evaluation of installation.

(5) *Hydraulic Integrity*

Requirement. The drainage, waste and vent system shall be air and water tight under conditions of *normal use.*

Criteria

(a) The major elements of the DWV system (building drains, stacks and horizontal branches) shall be leak tight when subjected to a pressure of 5 psi.

(b) The completed DWV system shall be leak tight when subjected to a pressure equivalent to a 2-inch water column.

Test

(a) *Rough Plumbing Test.* See test specified in 1.2.b. above.

(b) *Finished Plumbing Test.* See test specified in 1.2.b. above.

(6) *Functional Performance*

Requirement. The DWV system shall accept and transport spent water and liquid in a safe and efficient manner.

Criteria

(a) The DWV system shall not, under conditions of normal use, display any of the following failures:

- self-siphonage at any fixture trap
- trap seal reduction greater than one inch, indicating induced siphonage
- evidence of blowback at any fixture
- ejection of suds at any fixture
- evidence of cross-flow in any branches of back to back fixtures.

(b) Single stack DWV systems shall be deemed to conform to this performance guideline if designed in accordance with Section 1602, Chapter XVI of the Standard Plumbing Code.

(c) Automatic anti-siphon trap vent devices may be used in the DWV system, as permitted by model code having jurisdiction, and shall be in conformance with the applicable SBCCI and BOCA Research Reports.

(d) Reduced sized venting may be used in the DWV system of buildings under three stories in height, provided that the entire system shall be designed by a qualified professional engineer, in accordance with criteria and guidelines contained in the NBS publication, Building Science Series-60, "Hydraulic Performance of a Full Scale Townhouse System with Reduced-Sized Vents", August 1975.

(e) Code-accepted proprietary, engineered single sack DWV systems shall be designed and installed in accordance with the conditions of their acceptance.

Test

(a) *Functional Performance Tests.* See discussion in 1.2.c above.

(b) Evaluation in accordance with Chapter XVI, Standard Plumbing Code.

(c) Evaluation in accordance with applicable SBCCI or BOCA Research Reports.

(d) Evaluation in accordance with BSS–60.

Discussion. Compliance with this requirement can always be achieved by the addition of supplemental venting in DWV systems failing this test.

Appendix B

Examples of Acceptable DWV Practices for Building Rehabilitation

The following illustrated DWV practices have been determined to be adequate in solving problems of the type discussed in this guideline, based on engineering principles and the experience of recognized testing facilities. They do not represent all possible problems, nor do they reflect

the most extreme solutions in terms of deviation from the specific requirements of plumbing codes.

Symbols

WC, water closet; T, bathtub; L, lavatory; KS, kitchen sink; ———, new sanitary piping; ————————, existing sanitary piping; ———, vents.

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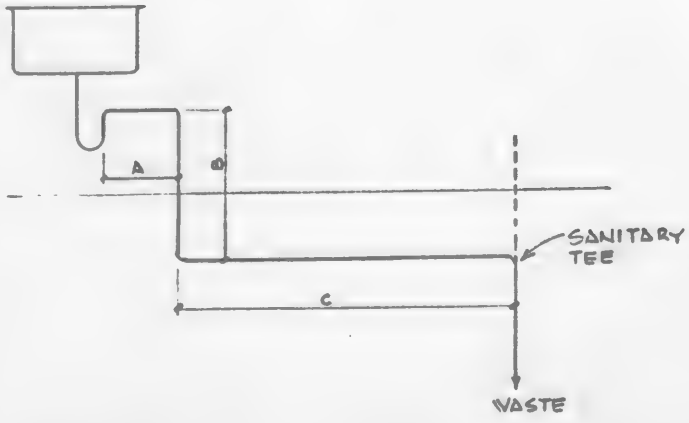

Figure 1

CORRECTION OF "S" TRAP SUBJECT TO SELF-SIPHONAGE IN FLAT BOTTOMED SINKS

Illustration of solution to problem 2.1(5).

A = not more than 10 pipe diameters
B = not more than 24 pipe diameters
C = not more than 72 pipe diameters

- all pipe 2" diameter
- 1½" trap

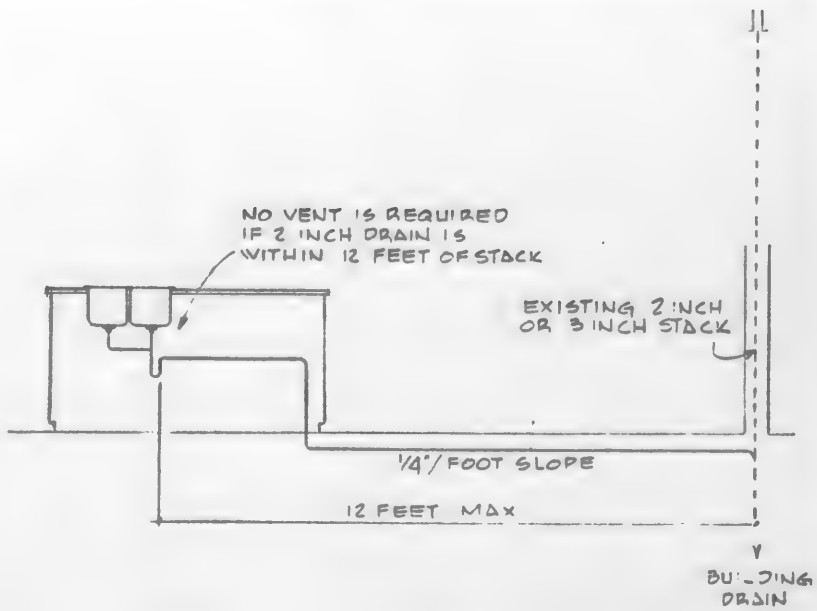
NO VENT IS REQUIRED IF 2 INCH DRAIN IS WITHIN 12 FEET OF STACK
EXISTING 2 INCH OR 3 INCH STACK
¼"/FOOT SLOPE
12 FEET MAX
BUILDING DRAIN

Figure 2

ISLAND SINK

Example of solution to problem 2.2.

- all pipe 2" diameter
- 1½" trap

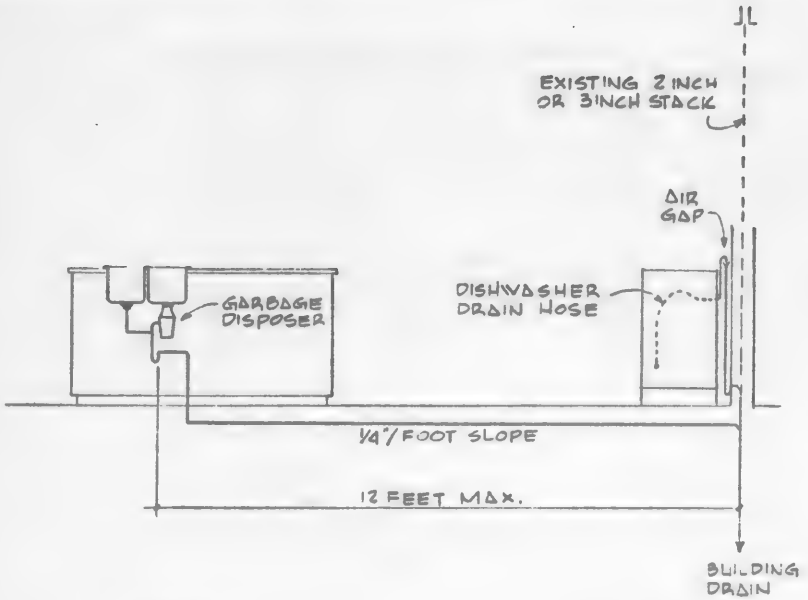

Figure 3

ISLAND SINK WITH DISPOSER AND DISHWASHER AT WALL

Example of solution to problem 2.2.

Note that required location of dishwasher air gap may vary by local code.

- all pipe 2" diameter
- 1½" trap

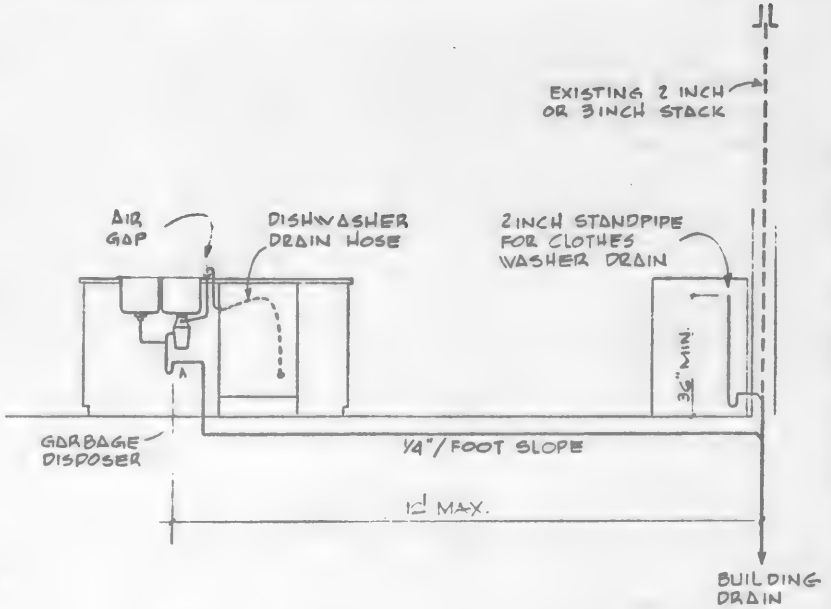

Figure 4

ISLAND SINK WITH DISPOSER, DISHWASHERS, AND CLOTHES WASHER AT WALL

Example of solution to problem 2.2.

Note that required location of dishwasher air gap may vary by local code.

- all pipe 2" diameter
- 1½" trap

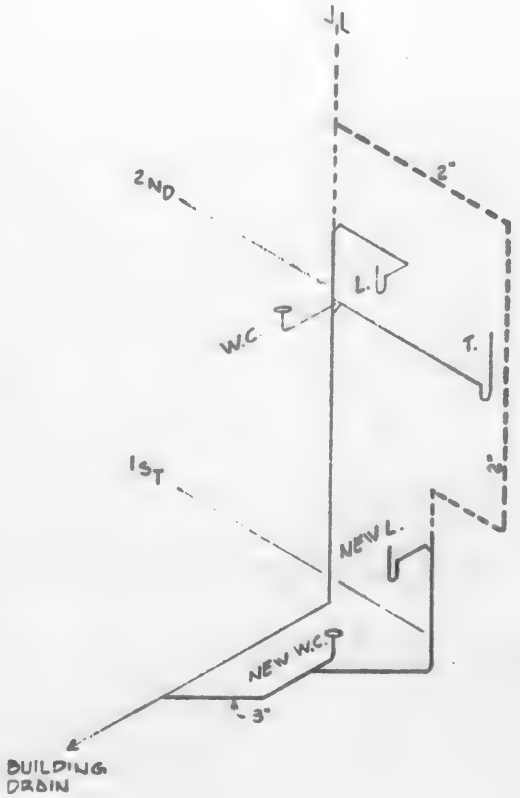

Figure 5

ADDITION OF FIRST FLOOR POWDER ROOM OF SINGLE DWELLING UNIT, SLAB ON GRADE

Illustration of use of wet venting in solving a problem of the type discussed under 2.3. For possible use of single stack solutions, see 1.3(4) and discussion under 2.3.

Note that new branch drain line may enter building drain on stack.

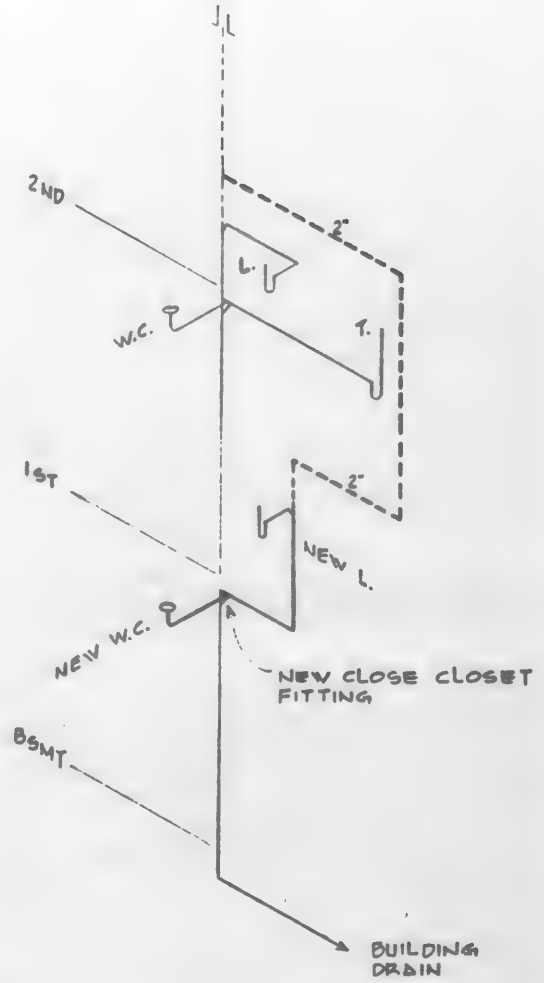

Figure 6

ADDITION OF FIRST FLOOR POWDER ROOM OF SINGLE DWELLING UNIT, WITH BASEMENT

Illustration of use of wet venting in solving a problem of the type discussed under 2.3. For possible use of single stack solutions, see 1.3(4) and discussion under 2.3

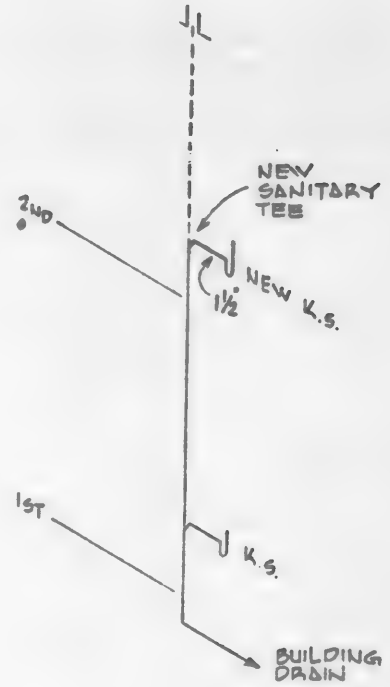

Figure 7

ADDITION OF SECOND FLOOR FIXTURE TO EXISTING STACK

A lavatory and bathtub may be added to the second floor of a stack vented bathroom group. Two inch diameter tub drain may run 10 feet maximum.

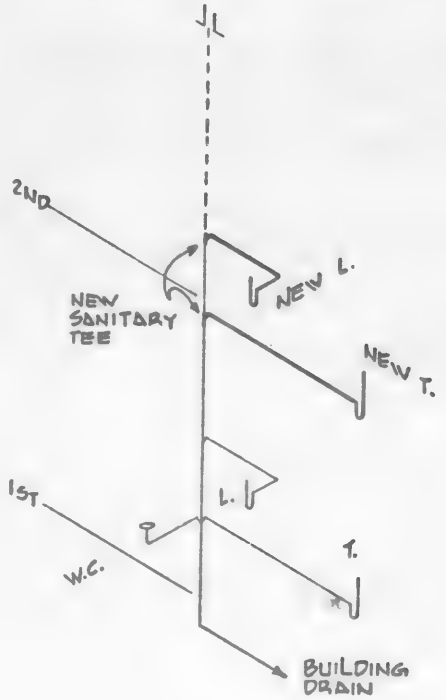

Figure 8

ADDITION OF SECOND FLOOR FIXTURE TO EXISTING STACK

A second kitchen sink, with or without disposer, may be added to an existing 2 inch waste stack. A 1½ inch fixture drain may run 7 feet maximum.

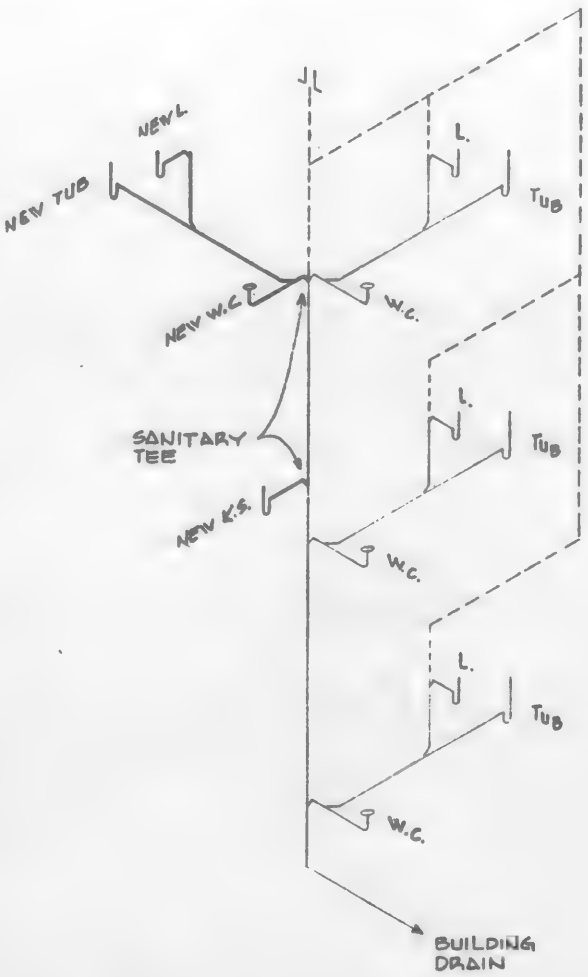

Figure 9

ADDITION OF KITCHEN SINK AND BATHROOM GROUP TO EXISTING 3-STORY STACK

Illustration of use of stack venting in solving a problem of the type discussed under 2.3

Kitchen sinks or bathroom groups may be added to an existing wet vented stack (4" stack required). of not more than three floors in height.

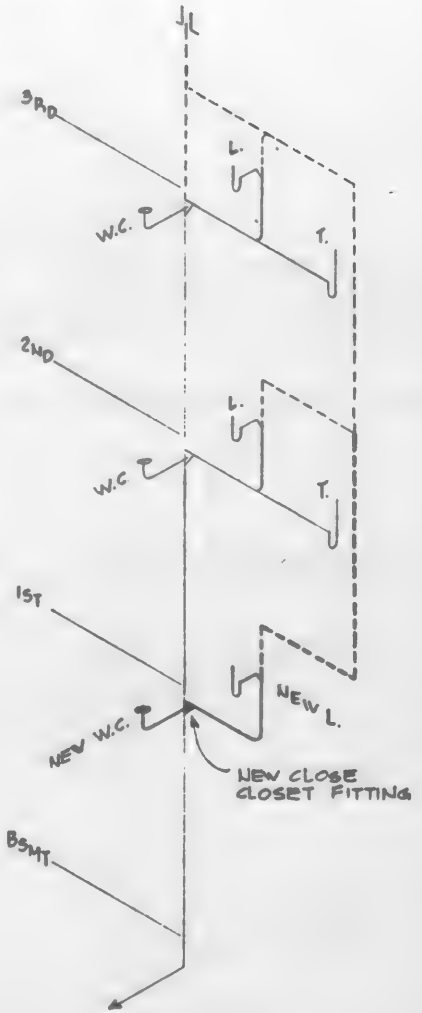

Figure 10

ADDITION OF FIRST FLOOR POWDER ROOM TO EXISTING 3-STORY STACK

Illustration of use of wet venting in solving a problem of the type discussed under 2.3.

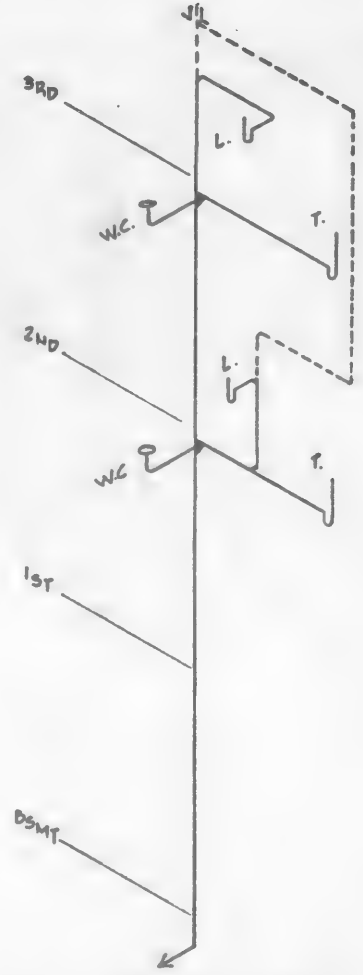

Figure 11

ADDITION OF SECOND OR THIRD FLOOR BATHROOM GROUP TO EXISTING 3-STORY STACK

For possible use of single stack solutions see 1.3(4) and discussion under 2.3.

Note that for addition of new water closet, tub, and lavatory to either second or third floor, second floor may be wet vented and third floor stack vented.

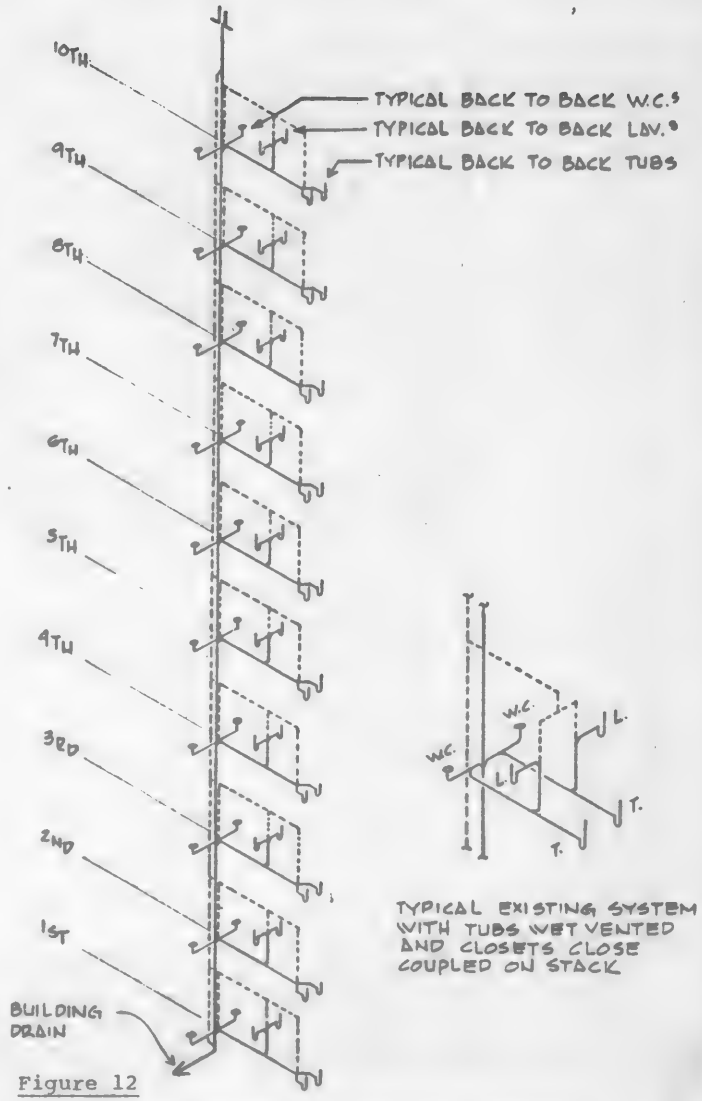

Figure 12

TYPICAL FULLY VENTED BACK-TO-BACK BATHROOM STACK WITH ALTERNATE SOLUTION

Illustration of use of wet venting in solving a problem of the type discussed under 2.3.

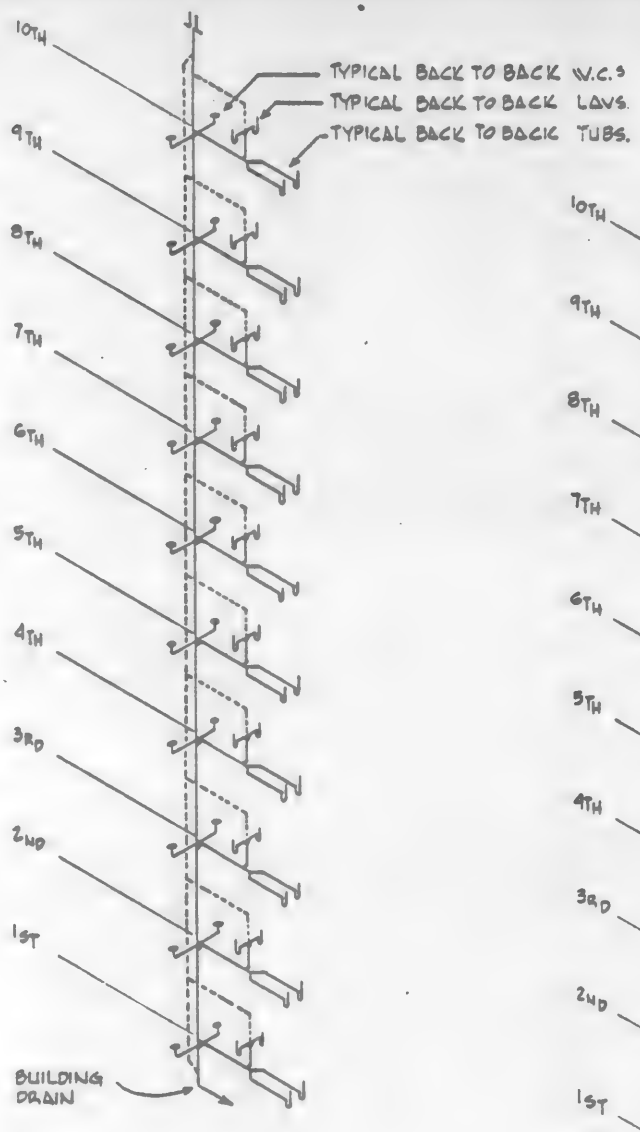

Figure 13

WET VENTING OF TUBS AND WATER CLOSETS

Illustration of possible solution to problem of the type discussed under 2.3.

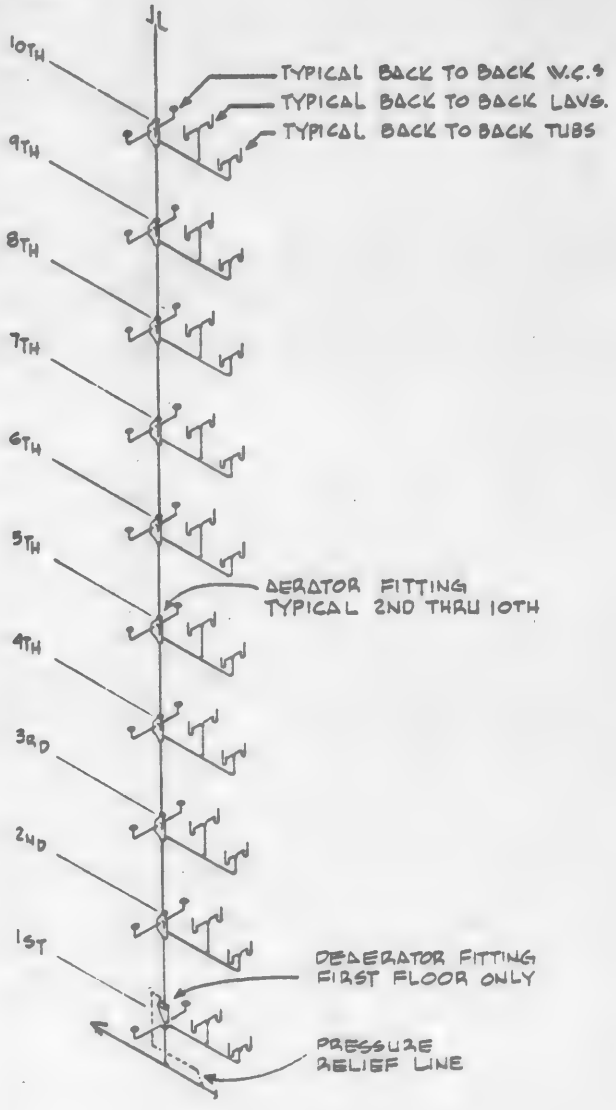

Figure 14

ENGINEERED SINGLE STACK SYSTEM SIZED ACCORDING TO PUBLISHED CRITERIA

Illustration of possible solution to problem of the type discussed under 2.3.

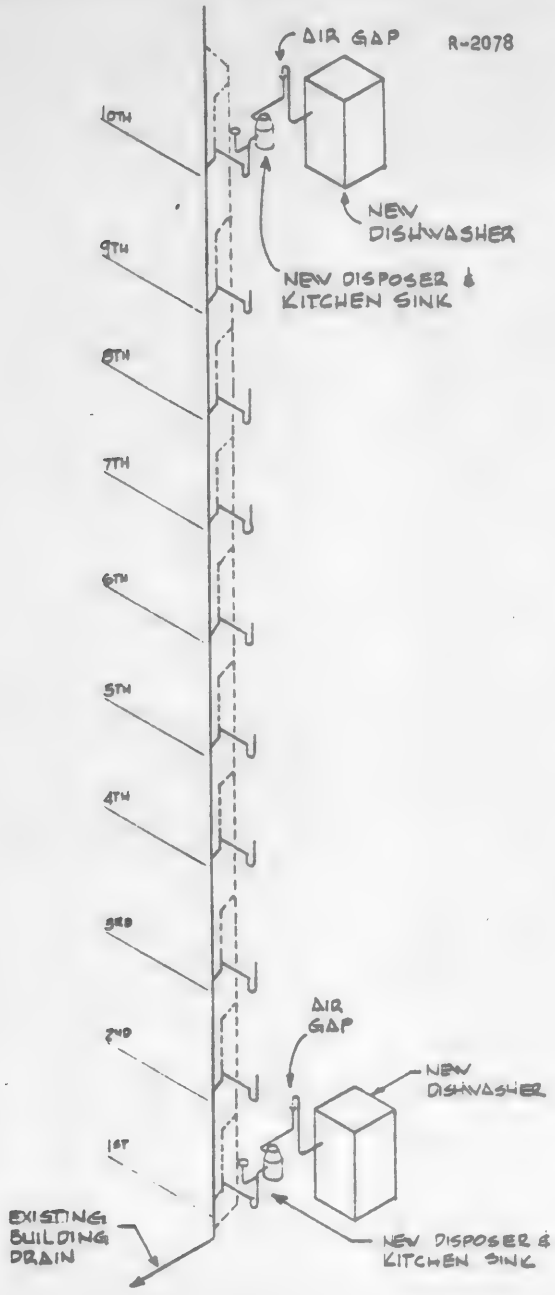

Figure 15

ADDITION OF DISPOSER AND DISHWASHER TO KITCHEN SINK ON EXISTING STACK

Illustration of acceptable addition of disposer and dishwasher to a 2 inch stack on every floor (see problem 2.3).

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Guideline on Fire Ratings of Archaic Materials and Assemblies

Table of Contents

Introduction.
Section I. Fire-Related Performance of Archaic Materials and Construction.
A. Fire Performance Measures.
Flame Spread.
Smoke Production.
Degree of Combustibility.
B. Combustible Construction Types.
Section II. Building Evaluation.
A. Preliminary Evaluation.
B. Fire Resistance of Existing Building Elements.
C. Effects of Penetrations in Fire Resistant Assemblies.
Section III Final Evaluation and Design Solutions.
A. The Experimental Approach.
B. The Theoretical Approach.
Harmathy's Ten Rules.
Example Applications of Harmathy's Rules.
C. "Thickness Design" Strategy.
D. Evaluation of Doors.
Section IV. Summary Guideline.
Appendix.
Introduction.
Section I. Walls.
Section II. Columns.
Section III. Floor Ceiling Assemblies.
Section IV. Beams.
Section V. Doors.
Bibliograph

Introduction

The *Guideline on Fire Ratings of Archaic Materials and Assemblies* focuses upon the fire-related performance of archaic construction. "Archaic" encompasses construction typical of an earlier time, generally prior to 1950. "Fire-related performance" includes fire resistance, flame spread, smoke production and degree of combustibility.

The purpose of this guideline is to update the information which was available at the time of original construction, for use by architects, engineers, and code officials when evaluating the fire safety of a rehabilitation project. The local manufacturing of many archaic materials means that there may never have been any fire test information available about the particular material of a given project. Information relevant to the evaluation of general classes of materials and types of construction is presented for these cases.

It has been assumed that the building materials and their fastening, joining, and incorporation into the building structue are sound mechanically. Therefore, some determination must be made that the original manufacture, the original construction practice, and the rigors of aging and use have not weakened the building. This assessment can often be difficult because process and quality control was not good in many industries, and variations among locally available raw materials and manufacturing techniques often resulted in a product which varied widely in its strength and durability. The properties of iron and steel, for example, varied widely, depending on the mill and the process used.

There is nothing inherently inferior about archaic materials or construction techniques. The pressures that promote fundamental change are most often economic or technological—matters not necessarily related to concerns for safety. The high cost of labor made wood lath and plaster uneconomical. The high cost of land and the congestion of the cities provided the impetus for high-rise construction. Improved technology made it possible. The difficulty with archaic materials is not a question of suitability, but familiarity.

Code requirements for the fire performance of key building elements (e.g., walls, floor/ceiling assemblies, doors, shaft enclosures) are stated in performance terms: hours of fire resistance. It matters not whether these elements were built in 1908 or 1980, only that they provide the required degree of fire resistance. This level of performance will be defined by the local community. The guideline is only a tool to help evaluate the various building elements, regardless of what the level of performance is required to be.

The problem with archaic materials is simply that documentation of their fire performance is not readily available. The application of engineering judgment is more difficult because building officials may not be familiar with the materials or construction method involved. As a result, either a fullscale fire test is required or the archaic construction in question removed and replaced. Both alternative are time consuming and wasteful.

This guideline and the accompanying Appendix are designed to help fill this information void. By providing the necessary documentation, there will be a firm basis for the continued acceptance of archaic materials and assemblies.

Section I Fire-Related Performance of Archaic Materials and Assemblies

A. Fire Performance Measures

This guideline does not specify the level of performance required for the various building components. These requirements are controlled by the building occupancy and use and are set forth in the local building or rehabilitation code.

The fire resistance of a given building element is established by subjecting a sample of the assembly to a "standard" fire test which follows a "standard" time temperature curve. This test method has changed little since the 1920's. The test results tabulated in the Appendix have been adjusted to reflect current test methods.

The current model building codes cite other fire-related properties not always tested for in earlier years: flame spread, smoke production, and degree of combustibility. However, they can generally be assumed to fall within well defined values because the principal combustible component of archaic materials is cellulose. Smoke production is more important today because of the increased use of plastics. However, the early flame spread tests, developed in the early 1940's, also included a test for smoke production.

"Plastics", one of the most important classes of contemporary materials, were not found in the review of archaic materials. If plastics are to be used in a rehabilitated building, they should be evaluated by contemporary standards. Information and documentation of their fire-related properties and performance is widely available.

Flame spread, smoke production and degree of combustibility are discussed in detail below. Test results for eight common species of lumber are noted in the following table:

Tunnel Test Results for Eight Species of Lumber (104)

Species of lumber	Flame spread	Fuel contributed	Smoke developed
Western white pine75 50–60 50			50
Northern white pine	120–215	120–140	50–65
Ponderosa pine	150–215	120–135	100–110
Yellow pine	150–190	130–145	275–305
Red gum	140–155	125–175	40–60
Yellow birch	105–110	100–105	45–65
Douglas fir	85–100	80–85	10–100
Western hemlock	60–75	40–65	40–120

Flame Spread

The flame spread of interior finishes is usually measured by the ASTM E–84 "tunnel test". The most commonly used flame spread classsifications (FSC) are: Class I or A,[1] with a 0–25 FSC; Class II or B, with a 26–75 FSC; and Class III or C, with a 76–200 FSC. The NFPA Life Safety Code also has a Class D (201–500 FSC) and Class E (over 500 FSC) interior finish. These classifications are typically used in modern building codes to restrict the rate of fire spread. Only the first three classifications are normally permitted, though not all classes of

[1] Some codes use Roman numerals, others use letters.

materials can be used in all places throughout a building. For example, the interior finish of building materials used in exits or in corridors leading to exits is more strictly regulated than materials used within private dwelling units.

In general, inorganic archaic materials (e.g., bricks or tile) can be expected to be in Class I. Materials of whole wood are mostly Class II. Whole wood is defined as wood used in the same form as sawn from the tree. This is in contrast to the contemporary reconstituted wood products such as plywood, fiberboard, hardboard or particle board. If the organic archaic material is not whole wood, the flame spread classification could be well over 200 and thus would be particularly unsuited for use in exits and other critical locations in a building. Some plywoods and various wood fiberboards have flame spreads over 200. Although they can be treated with fire retardants to reduce their flame spread, it would be advisable to assume that all such products have a flame spread over 200 unless there is information to the contrary.

Smoke Production

The evaluation of smoke density is part of the ASTM E–84 tunnel test. For the eight species of lumber shown in the table above, the highest levels are 275–305 for Yellow Pine, but the others are less smoky than red oak which has an index of 100. The advent of plastics caused substantial increases in the smoke density values measured by the tunnel test. The ensuing limitation of the smoke production for wall and ceiling materials by the model building codes has been a reaction to the introduction of plastic materials. In general, cellulosic materials fall in the 50–300 range of smoke density which is below the general limitation of 450 adopted by many codes.

Degree of Combustibility

There has been a tendency by the model building codes to define "noncombustibility" on the basis of having passed ASTM E–136 or if the material is totally inorganic. The acceptance of gypsum wallboard as noncombustible is based on limiting paper thickness to not over ⅛" and 0–50 flame spread classification (FSC) by ASTM E–84. At times there were provisions to define a Class I or A material (0–25 FSC) as noncombustible, but this is not currently recognized by most model building codes.

If there is any doubt whether or not an archaic material is noncombustible, it would be appropriate to send out samples for evaluation. If an archaic material is determined to be noncombustible according to ASTM E–136, it can be expected that it will not contribute fuel to the fire.

B. Combustible Construction Types

One of the earliest forms of timber construction utilized exterior load-bearing masonry walls with columns and/or wooden walls supporting wooden beams and floors in the interior of the building. This form of construction, often called "mill" or "heavy timber" construction, has approximately 1-hour fire resistance. The exterior walls will generally contain the fire within the building.

As population pressure increased and more lumber became available, there was a switch from heavy timber to "balloon frame" construction. The balloon frame uses load-bearing exterior wooden walls which have long timbers often extending from foundation to roof. When longer lumber became scarce, another form of construction, "platform" framing, replaced the balloon framing. The difference between the two systems is significant because platform framing is automatically fire-blocked at every floor while balloon framing commonly has concealed spaces that extend unblocked from basement to attic. The architect, engineer, and code official must be alert to the details of construction and the ease with which fire can spread in concealed spaces.

Section II Building Evaluation

A given rehabilitation project will most likely go through several stages. The preliminary evaluation process involves the designer in surveying the prospective building. The fire resistance of existing building materials and construction systems are identified; potential problems are noted for closer study. The final evaluation phase includes: developing design solutions to upgrade the fire resistance of building elements, if necessary; the preparation of working drawings and specifications; and the securing of the necessary code approvals.

A. Preliminary Evaluation

A preliminary evaluation should firstly consist of a building survey to determine the existing materials, the general arrangement of the structure, the use of the occupied space, and the details of construction. The designer needs to know "what is there" before a decision can be reached about what to keep and what to remove in the rehabilitation process. This preliminary evaluation should be as detailed as necessary to make initial plans. The fire-related properties need to be determined from the applicable building code, and the materials and assemblies existing in the building then need to be evaluated for these properties. Two work sheets are introduced below to facilitate the preliminary evaluation.

There are two possible sources of information that are relevant to the preliminary evaluation: original building plans and the building code in effect at the time of construction. Plans may be on file with the local building department or in the offices of the original design professionals (e.g., architect, engineer) or their successors. If plans are available, the investigator should verify that the building was actually constructed as called for in the plans, as well as incorporate any later alterations or changes to the building. Earlier editions of the local building code should be on file with the building official. The code in effect at the time of construction will contain fire performance criteria. While this is no guarantee that the required performance was actually provided, it does give the investigator some guidance as to the level of performance which may be expected. Under some code administration and enforcement systems, the code in effect at the time of construction also defines the level of performance that must be provided at the time of rehabilitation.

Table A is a suggested work sheet for the preliminary field notes. This work sheet lists the materials, thickness, and condition for each of the principal building elements. In addition to Table A, the field investigator should prepare a schematic diagram showing the exit system for the building and to indicate where each element from Table A fits into the structure as a whole. Each floor of the structure should be visited and the information in Table A completed. In practice, there will often be identical materials and construction on each floor, but the exception to this rule may be of vital importance. A drawing should be prepared of each floor showing the layout of exits and hallways. The exact arrangement of interior walls within apartments is of secondary importance from a fire safety point of view and need not be shown on the drawings unless these walls are required by the building code to have a fire resistance rating.

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TABLE A

PRELIMINARY EVALUATION

FIELD NOTES

Building Element		Materials	Dimension	Condition	Notes
Exterior Bearing Walls					
Interior Bearing Walls					
Exterior Non-Bearing Walls					
Interior Non-Bearing Walls or Partitions:	A				
	B				
Structural Frame:	Columns				
	Beams				
	Other				
Floor/Ceiling Structural System Spanning					
Roofs					
Doors (including frame and hardware):					
a) Enclosed vertical exitway					
b) Enclosed horizontal exitway					
c) Other					

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The location of stairways and elevators should be clearly marked on the drawings. All exterior means of escape (e.g., fire escapes) should be identified.[2]

The following notes explain the entries in Table A:

(i) *Exterior Bearing Walls:* Many old buildings utilize heavily constructed walls to support the floor/ceiling assemblies at the exterior of the building. There may be columns and/or interior bearing walls within the structure, but these exterior walls are an important factor in assessing the fire safety of a building.

The field investigator should note how the floor/ceiling assemblies are supported at the exterior of the building. If columns are incorporated in the exterior walls, the walls may be considered non-bearing.

(ii) *Interior Bearing Walls:* It may be difficult to determine whether or not an interior wall is load bearing, but the field investigator should attempt to make this determination. At a later stage of the rehabilitation process, this question will need to be determined exactly. Nevertheless, the field notes should be as accurate as possible.

(iii) *Exterior Non-Bearing Walls:* The fire resistance of the exterior walls is important for two reasons. These walls (both bearing and non-bearing) are depended upon to: a) contain a fire *within* the building; or b) keep an exterior fire *outside* the building. It is therefore important to indicate on the drawings where any openings are located as well as the nature of all doors or shutters. The drawings should indicate the presence of wired glass, its thickness and framing, and identify the materials used for windows and door frames. The protection of openings adjacent to exterior means of escape (e.g., exterior stairs, fire escapes) is particularly important. The ground floor drawing should locate the building on the property and indicate the precise distances to adjacent buildings.

(iv) *Interior Non-Bearing Walls (Partitions):* A partition is a "wall that extends from floor to ceiling and subdivides space within any story of a building." (48) Table A has two categories (A & B) for Interior Non-Bearing Walls (Partitions) which can be used for different walls, such as hallway walls as compared to inter-apartment walls. Under some circumstances there may be only one type of wall construction; in others, three or more types of wall construction may occur.

The field investigator should be alert for differences in function as well as in materials and construction details. As with the layout in general, the details within apartments are not as important as the major exit passages and stairwells. The preliminary field investigation should attempt to determine the thickness of all walls. A term introduced below called "thickness design" will depend on an accurate (± ¼") determination. Even though this intial field survey is called "preliminary", the data generated should be as accurate and complete as possible.

The field investigator should note the exact location from which his or her observations are recorded. For instance, if a hole is found through a stairwell wall which allows a cataloguing of the construction details, the field investigation notes should reflect the location of the "find." At the prliminary stage it is not necessary to core every wall; the interior details of construction can usually be determined at some location.

(v) *Structural Frame:* There may or may not be a complete skeletal frame, but usually there are columns, beams, trusses, or other elements. The dimensions and spacing of the structural elements should be measured and indicated on the drawings. For instance, if there are ten inch square columns located on a thirty foot square grid throughout the building, this should be noted. The structural material and cover or protective materials should be identified wherever possible. The thickness of the cover materials should be determined to an accuracy of ±¼". As discussed above, the preliminary field survey usually relies on accidental openings in the cover materials rather than a systematic coring technique.

(vi) *Floor/Ceiling Structural Systems:* The span between supports should be measured. If possible, a sketch of the cross-section of the system should be made. If there is no location where accidental damage has opened the floor/ceiling construction to visual inspection, it is necessary to make such an opening. An evaluation of the fire resistance of a floor/ceiling assembly requires detailed knowledge of the materials and their arrangement. Special attention should be paid to the cover on structural steel elements and the condition of suspended ceilings and similar membranes.

(vii) *Roofs:* The preliminary field survey of roof systems will generally focus mainly on water-tightness. However, once it is apparent that the roof is sound for ordinary use and can be retained in the rehabilitated building, it becomes necessary to evaluate its fire characteristics. The field investigator must measure the thickness and identify the types of materials which have been used. The investigator should be aware that there may be several layers of roof materials.

(viii) *Doors:* The doors to stairways and hallways represent some of the most important fire elements to be considered within a building.

The various uses are clearly differentiated in Table A. This should aid the field investigator in making careful measurements of the thickness of door panels and in the determination of the type of core material within each type of door. The presence of a self-closure on a door should be noted and the general operation of the doors should be checked. The latch should engage and the door should fit tightly in the frame. The hinges shoud be in good condition. If glass is used in the doors, it should be identified as either plain glass or wired glass mounted in either a wood or steel frame.

(ix) *Materials:* The field investigator should be able to identify ordinary building materials. In situations where an unfamiliar material is found, a sample should be obtained. This sample should measure at least 10 cubic inches so that an ASTM E–136 fire test can be conducted to detemine if it is combustible.

(x) *Thickness:* The thickness of all materials should be measured accurately since, under certain circumstances, the fire resistance rating is very sensitive to the material thickness.

(xi) *Condition:* The method of attaching the various layers and facings to one another or to the supporting structural element should be noted under the appropriate building element in the table. The "secureness" of the attachment and the general condition of the layers and facings should be noted here. The condition of the element and the different layers of materials is important, but at the preliminary stage a subjective judgment is sufficient for this evaluation process.

(xii) *"Notes:* The "Notes" column can be used for many purposes, but it might be a good idea to make specific references to field notes and/or drawings to complement the table.

The next step in the preliminary evaluation is to identify the required fire resistance and flame spread for each of the building elements. These are normally established by the local building code. Then, the fire performance of the existing building elements is determined. A comparison of the required and available ratings

[2] Problems providing adequate exiting are discussed at length in the *Egress Guideline for Residential Rehabilitation.*

will highlight any deficiencies. Ways of either upgrading or replacing deficient construction can then be identified. A suggested work sheet for organizing this information is given below as Table B.

B. Fire Resistance of Existing Building Elements

The fire resistance of the existing building elements can be estimated from the tables and histograms contained in the Appendix. The Appendix is organized first by type of building element: walls, columns, floor/ceiling assemblies, beams, and doors. Within each building element, the tables are organized by type of construction (e.g., masonry, metal, wood frame), and then further divided by minimum dimensions or thickness of the building element.

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TABLE B

PRELIMINARY EVALUATION

WORKSHEET

Building Element	Required Fire Resistance	Required Flame Spread	Estimated Fire Resistance	Estimated Flame Spread	Possible Upgrade	Possible Equivalent Protection	Notes
Exterior Bearing Walls							
Interior Bearing Walls							
Exterior Non-Bearing Walls							
Interior Non-Bearing Walls or Partitions	A						
	B						
Structural Frame:							
Columns							
Beams							
Other							
Floor/Ceiling Structural System Spanning							
Roofs							
Doors (including frame and hardware): a) Enclosed vertical exitway							
b) Enclosed horizontal exitway							
c) Others							

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A histogram precedes every table that has 10 or more entries. The X-axis measures fire resistance in hours; the Y-axis shows the number of entries in that table having a given level of fire resistance. The histograms also contain the location of each element within that table for easy cross-referencing.

The histograms, because they are keyed to the tables, can speed the preliminary investigation. For example, Table 1.3.2, "Wood Frame Walls 4" to less than 6" thick", contains 96 entries. Rather than study each table entry, the histogram shows that every wall listed in that table has a fire resistance of less than 2 hours. If the building code required the wall to have a 2-hour rating, the designer, with a minimum of effort, is made aware of a problem that requires closer study.

Suppose the code had only required a wall of 1-hour fire resistance. The histogram shows far fewer complying elements (19) than non-complying ones (77). If the existing element is not one of the 19 complying entries, there is a strong possibility the existing element is deficient. The histograms can also be used in the converse situation. If the existing element is not one of the smaller number of entries with a lower than required fire resistance, there is a strong possibility the existing element will be acceptable.

At some point the existing building component must be actually located within the tables. Otherwise, the fire resistance must be determined through one of the techniques presented in Section III of the guideline. Locating the building component not only guarantees the accuracy of the fire resistance rating, but also provides a source of documentation for the building official.

C. Effects of Penetrations in Fire Resistant Assemblies

There are often many features in existing walls or floor/ceiling assemblies which were not included in the original certification or fire testing. The most common example is pipes and utility wires passed through holes poked through the assembly. During the life of the building, many penetrations are added and by the time a building is ready for rehabilitation, it is not sufficient to just consider the fire resistance of the assembly as originally constructed. It is necessary to consider all penetrations and their impact upon fire performance. For instance, the fire resistance of corridor walls is not as important as the effect of plain glass doors or transoms. In fact, doors are the most important single class of penetrations.

A fully developed fire generates substantial quantities of heat and excess fuel capable of penetrating any holes which might be present in the walls or ceiling of the fire compartment. In general, this leads to a severe degradation of the fire resistance of those elements and to a greater potential for fire spread. This is particularly applicable to penetrations located high in a compartment where the positive pressure of the fire can force the unburned gases through the penetration.

Penetrations in a floor/ceiling assembly will generally completely negate the barrier qualities of the assembly, and will lead to rapid spread of fire to the space above. It will not be a problem, however, if the penetrations are filled with noncombustible materials strongly fastened to the structure. The upper half of walls are similar to the floor/ceiling assembly in that a positive pressure can reasonably be expected in the top of the room, and this will push hot and/or burning gases through the penetration unless it is completely sealed.

Building codes require doors installed in fire resistive walls to resist the passage of fire for a specified period of time. If the door to a fully involved room is not closed, a large plume of fire will typically escape through the doorway, preventing anyone from using the space outside the door while allowing the fire to spread. This is why door closers are so important. Glass in doors and transoms can be expected to rapidly shatter unless constructed of listed or approved wire glass in a steel frame. As with other building components, penetrations or non-rated portions of doors and transoms must be upgraded or otherwise protected.

Table 5.1 in Section V of the Appendix contains 41 entries of doors mounted in sound tightfitting frames. Section III (D) below outlines one procedure for evaluating and possibly upgrading existing doors.

Section III Final Evaluation and Design Solutions

The final evaluation begins after the rehabilitation project has reached the final design stage and the choices made to keep certain archaic materials and assemblies in the rehabilitated building. The specific fire resistance and flame spread requirements are determined for the project. This may involve local building and fire officials reviewing the preliminary evaluation as depicted on Table A, Table B, and the field drawings and notes. The final evaluation process is essentially a more refined and detailed version of the preliminary evaluation. When necessary, provisions must be made to upgrade existing building components to provide the required level of fire resistance.

This section identifies specific approaches to design solutions that can make possible the continued use of archaic materials and assemblies in the rehabilitated structure. The simplest case occurs when the materials and assembly in question are found within the Appendix Tables and the fire performance properties satisfy code requirements. Other approaches must be used, though, if the assembly cannot be found within the Appendix or the fire performance needs to be upgraded. These approaches have been grouped into two classes: experimental and theoretical.

A. The Experimental Approach

If the fire resistance rating of a material and/or assembly found in a building is not given in the Appendix Tables of this report, there are several other ways to evaluate its fire performance. One approach is to conduct the appropriate fire test(s) and thereby determine the fire-related properties directly. There are a number of laboratories in the United States which routinely conduct the various fire tests. A current list can be obtained by writing the Center for Fire Research, National Bureau of Standards, Washington, D.C. 20234.

The contract with any of these testing laboratories should require their observation of specimen preparation as well as the testing of the specimen. A complete description of where and how the specimen was obtained from the building, the transportation of the specimen, and its preparation for testing should be noted in detail so that the building official can be satisfied that the fire test is representative of the actual use of the material in the building.

The test report should describe the fire test procedure and the response of the material or assembly. The laboratory usually submits a cover letter with the report to describe the provisions of the fire test that were satisfied by the material or assembly under investigation. A building official will generally require this cover letter, but will also read the report to confirm that the material or assembly complies with the code requirements. Local code officials should be involved in all phases of the testing process.

The experimental approach can be costly and time consuming because specimens must be taken from the building and transported to the testing laboratory. When a load bearing assembly has continuous reinforcement,

the test specimen must be removed from the building, transported, and tested in one piece. However, when the fire performance cannot be determined by other means, there may be no alternative to a full-scale test.

A "non-standard" small-scale test can be used in special cases. Sample sizes need only be 10–25 square feet, while full-scale tests require test samples of either 100 or 180 square feet in size. This small-scale test is best suited for testing non-load bearing assemblies against thermal transmission only.

B. The Theoretical Approach

There will be instances when certain materials and assemblies in a building undergoing rehabilitation cannot be found in the Appendix Tables. Even in those cases where test results are available for more or less similar construction, the proper classification may not be imnmediately apparent. Variations in dimensions, loading conditions, materials, or workmanship may markedly affect the performance of the individual building elements, and the extent of such a possible effect cannot be evaluated from the tables.

Theoretical methods being developed offer an alternative to the full-scale fire tests discussed above. For example, Section 4302(b) of the 1979 Edition of the Uniform Building Code specifically allows an engineering design for fire resistance in lieu of conducting full scale tests. These techniques draw upon computer simulation and mathematical modeling, thermodynamics, heat-flow analysis, and materials science to predict the fire performance of building materials and assemblies.

Another theoretical method known as the "Ten Rules of Fire Endurance Ratings" was published by T. Z. Harmathy in the May, 1965 edition of *Fire Technology*. (35) Using the data from the Appendix as a base, Harmathy's Rules provide a foundation for extending the data to analyze or upgrade current as well as archaic building materials or assemblies.

Harmathy's Ten Rules

Rule 1: The "thermal" [3] fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the "thermal" fire endurances characteristic of the individual layers when exposed separately to fire.

(i) The minimum performance of an untested assembly can be estimated if the fire endurance of the individual components is known. Though the exact rating of the assembly cannot be stated, the endurance of the assembly is greater than the sum of the endurance of the components.

(ii) When a building assembly or component is found to be deficient, the fire endurance can be upgraded by providing a protective membrane. This membrane could be a new layer of brick, plaster, or drywall. The fire endurance of this membrane is called the "finish rating." Tables 1.5.1 and 1.5.2 contain the finish ratings for the most commonly employed materials. (See note (ii) to Rule 2).

(iii) The test criteria for the finish rating is the same as for the thermal fire endurance of the total assembly: average temperature increases of 250° F above ambient or 325° F above ambient at any one place with the membrane being exposed to the fire. The temperature is measured at the interface of the assembly and the protective membrane.

Rule 2: The fire endurance of a construction does not decrease with the addition of further layers.

(i) Harmathy notes that this rule is a consequence of the previous rule. Its validity also follows from the fact that, by the addition of further layers, both the resistance to heat flow and the heat capacity of the construction increase, which, in turn, reduce the rate of temperature rise at the unexposed surface.

(ii) This rule is not just restricted to "thermal" performance but affects the other fire test criteria: direct flame passage, cotton waste ignition, and load bearing performance. This means that certain restrictions must be imposed on the materials to be added and on the loading conditions. One restriction is that new layer, if applied to the exposed surface, must not produce additional thermal stresses in the construction, i.e., its thermal expansion characteristics must be similar to those of the adjacent layer. Each new layer must also be capable of contributing enough additional strength to the assembly to sustain the added dead load. If this requirement is not fulfilled, the allowable live load must be reduced by an amount equal to the weight of the new layer. Because of these limitations, this rule should not be applied without careful consideration of these restrictions.

(iii) Particular care must be taken if the material added is a good thermal insulator. Preperly located, the added insulation could improve the "thermal" performance of the assembly. Improperly located, the insulation could block necessary thermal transmission through the assembly, thereby subjecting the structural elements to greater temperatures for longer periods of time, and could cause premature structural failure of the supporting members.

Rule 3: The fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but contining no air gaps or cavities.

(ii) By providing for voids in a construction, additional resistances are produced in the path of heat flow. Numerical heat flow analyses indicate that a 10 to 15 percent increase in fire endurance can be achieved by creating an air gap at the mid-plane of a brick wall. Since the gross volume is also increased by the presence of voids, the air gaps and cavities have a beneficial effect on stability as well. However, constructions containing combustible materials within an air gap may be regarded as exceptions to this rule because of the possible development of burning in the gap.

(ii) There are numerous examples of this rule in the tables. For instance:

Table 1.1.4; Item W–8–M–82: Cored concrete masonry, nominal 8" thick wall with *one unit* in wall thickness and with 62 percent minimum of solid material in each unit, load bearing (80 PSI). *Fire endurance is 2½ hours.*

Table 1.1.5; Item W–10–M–11: Cored concrete masonry, nominal 10" thick wall with *two units* in wall thickness and a 2" *air space,* load bearing (80 PSI). The units are essentially the same as item W–8–M–82. *Fire endurance is 3½ hours.*

These walls show 1-hour greater fire endurance by the addition of the 2" air space.

Rule 4: The farther an air gap or cavity is located from the exposed surface, the more beneficial is its effect on the fire endurance.

(i) Radiation dominates the heat transfer across an air gap or cavity, and it is markedly higher where the temperature is higher. The air gap or cavity is thus a poor insulator if it is located in a region which attains high temperatures during fire exposure.

(ii) Some of the clay tile designs take advantage of these factors. The double cell design, for instance, insures that there is a cavity near the unexposed face. Some floor/ceiling assemblies have air gaps or cavities near the top surface and these enhance their thermal performance.

Rule 5: The fire endurance of a construction cannot be increased by

[3] The "thermal" fire endurance is the time at which the average temperature on the unexposed side of a construction exceeds its initial value by 250° F when the other side is exposed to the "standard" fire specified by ASTM Test Method E–119.

increasing the thickness of a completely enclosed air layer.

(i) Harmathy notes that there is evidence that if the thickness of the air layer is larger than about ½ inch, the heat transfer through the air layer depends only on the temperature of the bounding surfaces, and is practically independent of the distance between them. This rule is not applicable if the air layer is not completely enclosed, i.e., if there is a possibility of fresh air entering the gap at an appreciable rate.

Rule 6: Layers of materials of low thermal conductivity are better utilized on that side of the construction on which fire is more likely to happen.

(i) As in Rule 4, the reason lies in the heat transfer process, but here the conductivity of the solid is much less dependent on the ambient temperature. The low thermal conductor allows a substantial temperature gradient to be established across its thickness under transient heat flow conditions. This rule may not be applicable to materials undergoing physico-chemical changes accompanied by significant heat absorption or heat evolution.

Rule 7: The fire endurance of asymmetrical constructions depends on the direction of heat flow.

(i) This rule is a consequence of Rules 4 and 6 as well as other factors. This rule is useful in determining the relative protection of corridors and stairwells from the surrounding spaces. In addition, there are often situations where a fire is more likely, or potentially more severe, from one side or the other.

Rule 8: The presence of moisture, if it does not result in explosive spalling, increases the fire endurance.

(i) The flow of heat into an assembly is greatly hindered by the release and evaporation of the moisture found within cementitious materials such as gypsum, portland cement, or magnesium oxychloride. Harmathy has shown that the gain in fire endurance may be as high as 8 percent for each percent (by volume) of moisture in the construction. It is the moisture chemically bound within the construction material at the time of manufacture or processing that leads to increased fire endurance. There is not direct relationship between the relative humidity of the air in the pores of the material and the increase in fire endurance.

(ii) Under certain conditions there may be explosive spalling of low permeability cementitious materials such as dense concrete. In general, one can assume that extremely old concrete has developed enough minor cracking that this factor should not be significant.

Rule 9: Load-supporting elements, such as beams, girders and joists, yield higher fire endurances when subjected to fire endurance tests as parts of floor, roof, or ceiling assemblies than they would when tested separately.

(i) One of the fire endurance test criteria is the ability of a load-supporting element to carry its design load. The element will be deemed to have failed when the load can no longer be supported.

(ii) Failure usually results for two reasons. Some materials, particularly steel and other metals, lose much of their structural strength at elevated temperatures. Physical deflection of the supporting element, due to decreased strength or thermal expansion, causes a redistribution of the load forces and stresses throughout the element. Structural failure often results because the supporting element is not designed to carry the redistributed load.

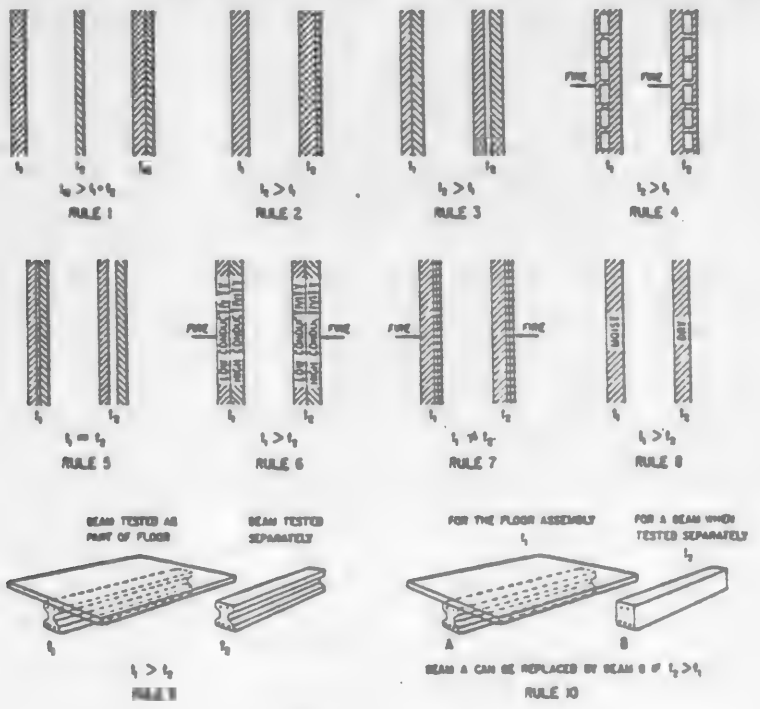
(iii) Roof, floor, and ceiling assemblies have primary (e.g., beams) and secondary (e.g., floor joists) structural members. Since the primary load-supporting elements span the largest distances, their deflection becomes significant at a stage when the strength of the secondary members (including the roof or floor surface) is hardly affected by the heat. As the secondary members follow the deflection of the primary load-supporting element, an increasingly larger portion of the load is transferred to the secondary members.

When load-supporting elements are tested separately, the imposed load is constant and equal to the design load throughout the test. By definition, no distribution of the load is possible because the element is being tested by itself. Without any other structural members to which the load could be transferred, the individual elements cannot yield a higher fire endurance than they do when tested as parts of a floor, roof or ceiling assembly.

Rule 10: The load-supporting elements (beams, girders, joists, etc.) of a floor, roof, or ceiling assembly can be replaced by such other load-supporting elements which, when tested separately, yielded fire endurances not less than that of the assembly.

(i) This rule depends on Rule 9 for its validity. A beam or girder, if capable of yielding a certain performance when tested separately, will yield an equally good or better performance when it forms a part of a floor, roof or ceiling assembly. It must be emphasized that the supporting element of one assembly must not be replaced by the supporting element of another assembly if the performance of this latter element is not known from a separate (beam) test. Because of the load-reducing effect of the secondary elements that results from a test performed on an assembly, the performance of the supporting element alone cannot be evaluated by simple arithmetic. This rule also indicates the advantage of performing separate fire tests on primary load-supporting elements.

Harmathy (35) provided one schematic figure which illustrated his Rules. This is shown below.* It should be useful as a quick reference to assist in applying his Rules.



Diagrammatic illustration of ten rules.

t = fire endurance

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Example Applications of Harmathy's Rules

The following examples, based in whole or in part upon those presented in Harmathy's paper (35), show how the Rules can be applied to practical cases.

Example 1

A. *Problem*

(i) A contractor would like to keep a partition which consists of a 3¾ inch thick layer of red clay brick, a 1¼ inch thick layer of plywood and a ⅜ inch thick layer of gypsum wallboard, at a location where 2-hour fire endurance is required. Is this assembly capable of providing a 2-hour protection?

B. *Solution*

(i) This partition does not appear in the Appendix Tables.

(ii) Bricks of this thickness yield fire endurances of approximately 75 minutes (Table 1.1.2, Item W–4–M–2).

(iii) The 1¼ inch thick plywood has a finish rating of 30 minutes. (iv) The ⅜ inch gypsum wallboard has a finish rating of 10 minutes.

(v) Using the recommended values from the Tables and applying Rule 1, the

fire endurance of the assembly is larger than the sum of the layers, or

$>75+30+10=115$ minutes

C. *Discussion*

(i) This example illustrates how the Appendix Tables can be utilized to determine the fire resistance of assemblies not explicitly listed.

Example 2

A. *Problem*

(i) A number of buildings to be rehabilitated have the same type of roof slab which is supported with different structural elements.

(ii) The designer and contractor would like to determine whether or not this roof slab is capable of yielding a 2-hour fire endurance. According to a rigorous interpretation of ASTM E–119, however, only the roof assembly, including the roof slab as well as the cover and the supporting elements, can be subjected to a fire test. Therefore, a fire endurance classification cannot be issued for the slab separately.

(iii) The designer and contractor believe this slab will yield a 2–hour fire endurance even without the cover, and any beam of at least 2–hour fire endurance may serve as satisfactory support. Is it possible to obtain a classification for the slab separately?

B. *Solution*

(i) The answer to the question is yes.

(ii) According to Rule 10 it is not contrary to common sense to test and classify roofs and supporting elements separately. Furthermore, according to Rule 2, if the roof slabs actually yield a 2–hour fire endurance, the endurance of an assembly, including the slabs, cannot be less than two hours.

(iii) The recommended procedure would be to review the tables to see if the slab appears as part of any tested roof or floor/ceiling assembly. The supporting system can be regarded as separate from the slab specimen, and the fire endurance of the assembly listed in the table is at least the fire endurance of the slab. There would have to be an adjustment for the weight of the roof cover in the allowable load if the test specimen did not contain a cover.

(iv) The supporting structure or element would have to have at least a 2–hour fire endurance when tested separately.

C. *Discussion*

If the tables did not include tests on assemblies which contained the slab, one procedure would be to assemble the roof slabs on any convenient supporting system (not regarded as part of the specimen) and to subject them to a load which, besides the usually required superimposed load, includes some allowances for the weight of the cover.

Example 3

A. *Problem*

(i) A steel-joisted floor and ceiling assembly is known to have yielded a fire endurance of 1 hour and 35 minutes. At a certain location, a 2–hour fire endurance is required. What is the most economical way of increasing the fire endurance by at least 25 minutes?

B. *Solution*

(i) The most effective technique would be to increase the ceiling plaster thickness. Existing coats of paint would have to be removed and the surface properly prepared before the new plaster could be applied. Other materials (e.g., gypsum wallboard) could also be considered.

(ii) There may be another technique based on other principles, but an examination of the drawings would be necessary.

C. *Discussion*

(i) The additional plaster has at least three effects:

a) The layer of plaster is increased and thus there is a gain of fire endurance (Rule 1).

b) There is a gain due to shifting the air gap farther from the exposed surface (Rule 4).

c) There is more moisture in the path of heat flow to the structural elements (Rules 7 and 8).

(ii) The increase in fire endurance would be at least as large as that of the finish rating for the added thickness of plaster. The combined effects in (i) above would further increase this by a factor of 2 or more, depending upon the geometry of the assembly.

Example 4

A. *Problem*

(i) The fire endurance of item W–10–M–1 in Table 1.1.5 is 4-hours.This wall consists of two 3¾ inch thick layers of structural tiles separated by a 2-inch air gap and ¾" Portland cement plaster or stucco on both sides. If the actual wall in the building is identical to item W–120–M–1 except that it has a 4–inch air gap, can the fire endurance be estimated at 5 hour-

B. *Solution*

(i) The answer to the question is no.

(ii) Reason contained in Rule 5.

Example 5

A. *Problem*

(i) In order to increase the insulating value of its precast roof slabs, a company has decided to make the slabs using two layers of different concretes. The lower layer of the slabs, where the strength of the concrete is immaterial (all the tensile load is carried by the steel reinforcement), is now made from a concrete of low strength but good insulating value, For the upper layer, where the concrete is supposed to carry the compressive load, the original high strength, high thermal conductivity concrete has been retained, How will the fire endurance of the slabs be affected by the changes?

B. *Solution*

The effect on the thermal fire endurance is beneficial:

(i) The total resistance to heat flow of the new slabs has been increased due to the replacement of a layer of high thermal conductivity by one of low conductivity.

(ii) The layer of low conductivity is on the side more likely to be exposed to fire, where it is more effectively utilized according to Rule 6. The layer of low thermal conductivity also provides better protection for the steel reinforcement, thereby extending the time before reaching the temperature at which the creep of steel becomes significant.

C. "Thickness Design" Strategy

If a given wall does not appear in the tables, a rehabilitation designer can utilize a "thickness design" strategy for walls which is based on Harmathy's Rules 1 and 2.

This "thickness design" approach is used when the materials have been identified and measured, but the specific wall is not included in the tables. The first step is to survey thinner walls to see if the same materials have been fire tested and if thinner walls have yielded the desired or greater fire endurance. If that is the case, then the thicker walls in the building have more than enough fire resistance. The thickness of the walls thus becomes the principal concern.

This approach can also be used for floor/ceiling assemblies, except that the thickness of the cover [4] and the slab become the central concern. The fire resistance of the untested assembly will be at least the fire resistance of an assembly listed in the table having a similar design but with less cover and/or thinner slabs. For other structural elements (e.g., beams and columns), the element listed in the table must be of a similar design but with less cover thickness.

D. Evaluation of Doors

A separate section on doors has been included because the process for evaluation presented below differs from those suggested previously for other building elements. The impact of

[4] Cover: The protective layer of membrane of material which slows the flow of heat to the structural elements.

unprotected openings or penetrations in fire resistant assemblies has been detailed in Section II (C) above. It is sufficient to note here that openings left unprotected will likely lead to failure of the barrier under actual fire conditions.

For other types of building elements (e.g., beams, columns), the Appendix Tables can be used to establish a minimum level of fire performance. The benefit to rehabilitation is that the need for a full-scale fire test is then eliminated. For doors, however, this cannot be done. The data contained in Appendix Table 5.1, "Resistance of Doors to Fire Exposure", can only provide guidance as to whether a successful fire test is even feasible.

For example, a door required to have 1-hour fire resistance is noted in the tables as providing only 5 minutes. The likelihood of achieving the required 1-hour, even if the door is upgraded, is remote. The ultimate need for replacement of the doors is reasonably clear, and the expense and time needed for testing can be saved. However, if the performance documented in the table is near or in excess of what is being required, then a fire test should be conducted. The test documentation can then be used as evidence of compliance with the required level of performance.

The table entries cannot be used as the sole proof of performance of the door in question because there are too many unknown variables which could measurably affect fire performance. The wood may have dried over the years; coats of flammable varnish could have been added. Minor deviations in the internal construction of a door can result in significant differences in performance. Methods of securing inserts in panel doors can vary. The major non-destructive method of analysis, an x-ray, often cannot provide the necessary detail. It is for these, and similar reasons, that a fire test is still felt to be necessary.

It is often possible to upgrade the fire performance of an existing door. Sometimes "as is" and modified doors are evaluated in a single series of tests when failure of the unmodified door is expected. Because doors upgraded after an initial failure must be tested again, there is a potential savings of time and money.

The most common problems encountered are plain glass, panel inserts of insufficient thickness, and improper fit of a door in its frame. The latter problem can be significant because a fire can develop a substantial positive pressure, and the fire will work its way through otherwise innocent-looking gaps between door and frame.

One approach to solving these problems is as follows. The plain glass is replaced with approved or listed wire glass in a steel frame. The panel inserts can be upgraded by adding an additional layer of material. Gypsum wallboard is often used for this purpose. Intumescent paint applied to the edges of the door and frame will expand when exposed to fire, forming an effective seal around the edges. This seal, coupled with the generally even thermal expansion of a wood door in a wood frame, can prevent the passage of flames and other fire gases. The figure below illustrates these solutions.

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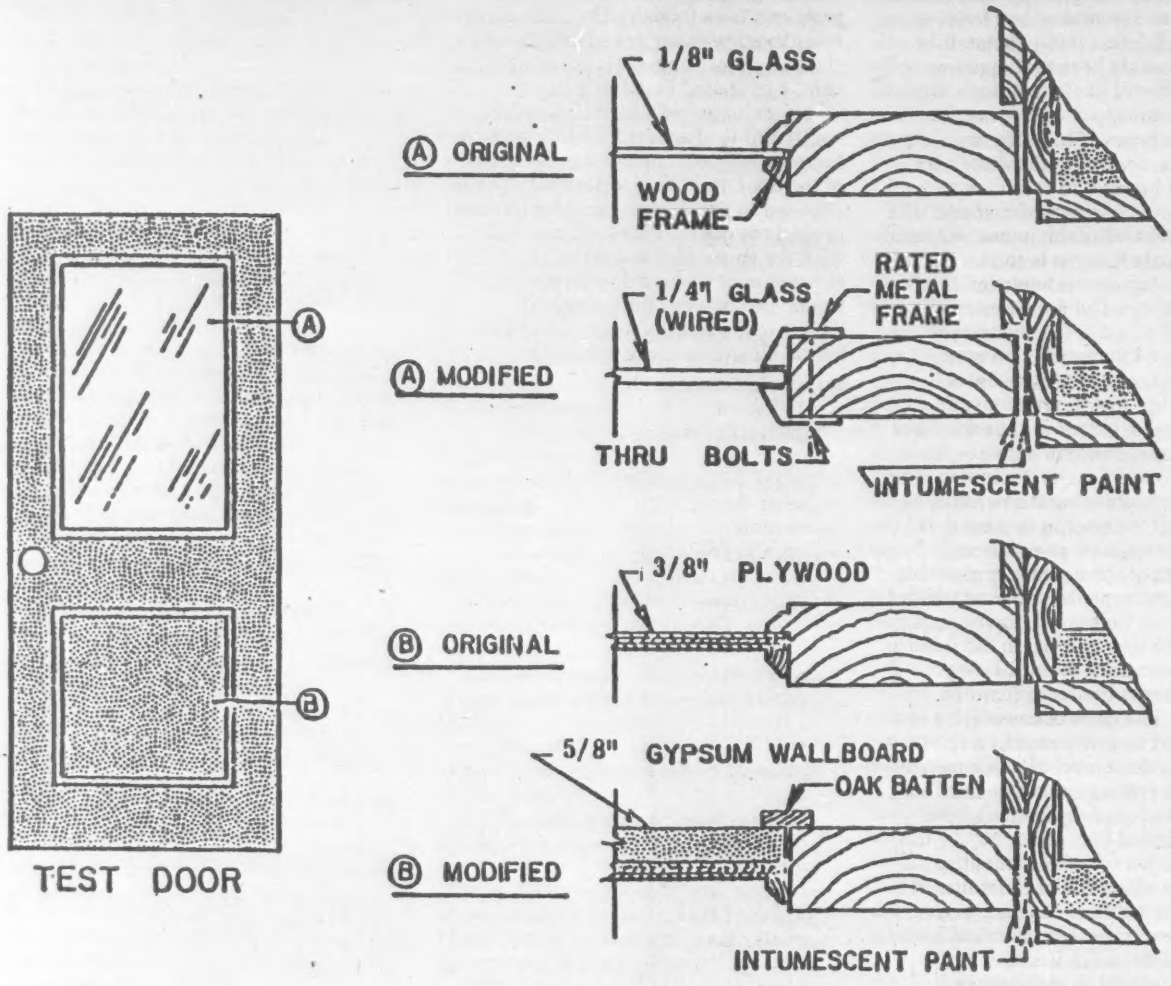

MODIFICATION DETAILS

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Because the interior construction of a door cannot be determined by a visual inspection, there is no absolute guarantee that the remaining doors are identical to the one(s) removed from the building and tested. But the same is true for doors constructed today, and reason and judgment must be applied. Doors that appear identical upon visual inspection can be weighed. If the weights are reasonably close, the doors can be assumed to be identical and therefore provide the same level of fire performance. Another approach is to fire test more than one door or to dismantle doors selected at random to see if they had been constructed in the same manner. Original building plans showing door details or other records showing that doors were purchased at one time or obtained from a single supplier can also be evidence of similar construction.

More often though, it is what is visible to the eye that is most significant. The investigator should carefully check the condition and fit of the door and frame, for frames out of plumb or separating from the wall. Door closers, latches, and hinges must be examined to see that they function properly and are tightly secured. If these are in order and the door and frame have passed a full-scale test, there can be a reasonable basis for allowing the existing doors to remain.

Section IV Summary Guideline

After the preliminary evaluation has been documented and a rehabilitation project is in the final design process, the need arises for specific guidelines for the evaluation of the fire-related performance of existing building elements. This section summarizes the various approaches and design solutions discussed in the preceeding Sections.

The term "structural system" includes: frames, beams, columns, and other structural elements. "Cover" has the meaning defined below: a protective layer(s) of materials or membrane which slows the flow of heat to the structural elements.

The following approaches (i) through (iii) shall be considered equivalent.

(i) The fire resistance of a building element can be established from the Appendix Tables. This is subject to the following limitations:

a. The building element in the rehabilitated building shall be constructed of the same materials with the same nominal dimensions as stated in the tables.

b. All penetrations in the building element or its cover for services such as electricity, plumbing, and HVAC shall be packed with noncombustible cementitious materials and so fixed that the packing material will not fall out when it loses its water of hydration.

c. The effects of age and wear and tear shall be repaired so that the building element is sound and the original thickness of all components, particularly covers and floor slabs, is maintained.

(ii) The fire resistance of a building element which does not explicitly appear in the Appendix Tables can be established if one or more elements of same design but different dimensions have been listed in the tables. For walls, the existing element must be thicker than the one listed. The fire resistance of the thicker wall shall be considered that of the thinner wall which appears in the table. For floor/ceiling assemblies, the assembly listed in the table must have the same or less cover and the same or thinner slab constructed of the same material as the actual floor/ceiling assembly. For other structural elements, the element listed in the table must be of a similar design but with less cover thickness. The fire resistance in all instances shall be the fire resistance rating recommended in the table. This is subject to the following limitations:

a. The actual element in the rehabilitated building shall be constructed of the same materials as listed in the table. Only the following dimensions may vary from those specified: for walls, the overall thickness must exceed that specified in the table; for floor/ceiling assemblies, the thickness of the cover and the slab must be greater than, or equal to, that specified in the table; for other structural elements, the thickness of the cover must be greater than that specified in the table.

b. All penetrations in the building element or its cover for services such as electricity, plumbing, or HVAC shall be packed with noncombustible cementitious materials and so fixed that the packing material will not fall out when it loses its water of hydration.

c. The effects of age and wear and tear shall be repaired so that the building element is sound and the original thickness of all components, particularly covers and floor slabs, is maintained.

(iii) The fire resistance of building elements can be established by applying Harmathy's Ten Rules of Fire Resistance Ratings as set forth in Section III (B). This is subject to the following limitations:

a. The data from the Tables can be utilized with the limitations a. through c. from Guideline (i) above.

(b) Test reports from recognized journals or published papers can be used to support data utilized in applying Harmathy's Rules.

c. Calculations utilizing recognized and well established computational techniques can be used in applying Harmathy's Rules. These include, but are not limited to, analysis of heat flow, mechanical properties, deflections, and load bearing capacity.

Commentary

(i) Guideline (i) essentially follows the approach taken by model building codes. The assembly must appear in a table either published in or accepted by the code for a given fire resistance rating to be recognized and accepted.

(ii) Guideline (ii) is an application of the "thickness design" concept presented in Section III (C). There should be many instances when a thicker building element was utilized than the one listed in the Appendix Tables. This Guideline recognizes the inherent superiority of a thicker design. Note: "thickness design" for floor/ceiling assemblies and structural elements refers to cover and slab thickness rather than total thickness.

(iii) The "thickness design" concept is essentially a special case of Guideline (iii) which takes special cognizance of Harmathy's Rules (specifically Rules 1 and 2). It should be recognized that the only source of data for Guideline (ii) is the Appendix Tables. If other data are used, it must be in connection with Guideline (iii).

(iv) The fire endurance of actual building elements can be greatly reduced or totally negated by removing part of the cover to allow pipes, ducts, or conduits to pass through the element. This must be repaired in the rehabilitation process.

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